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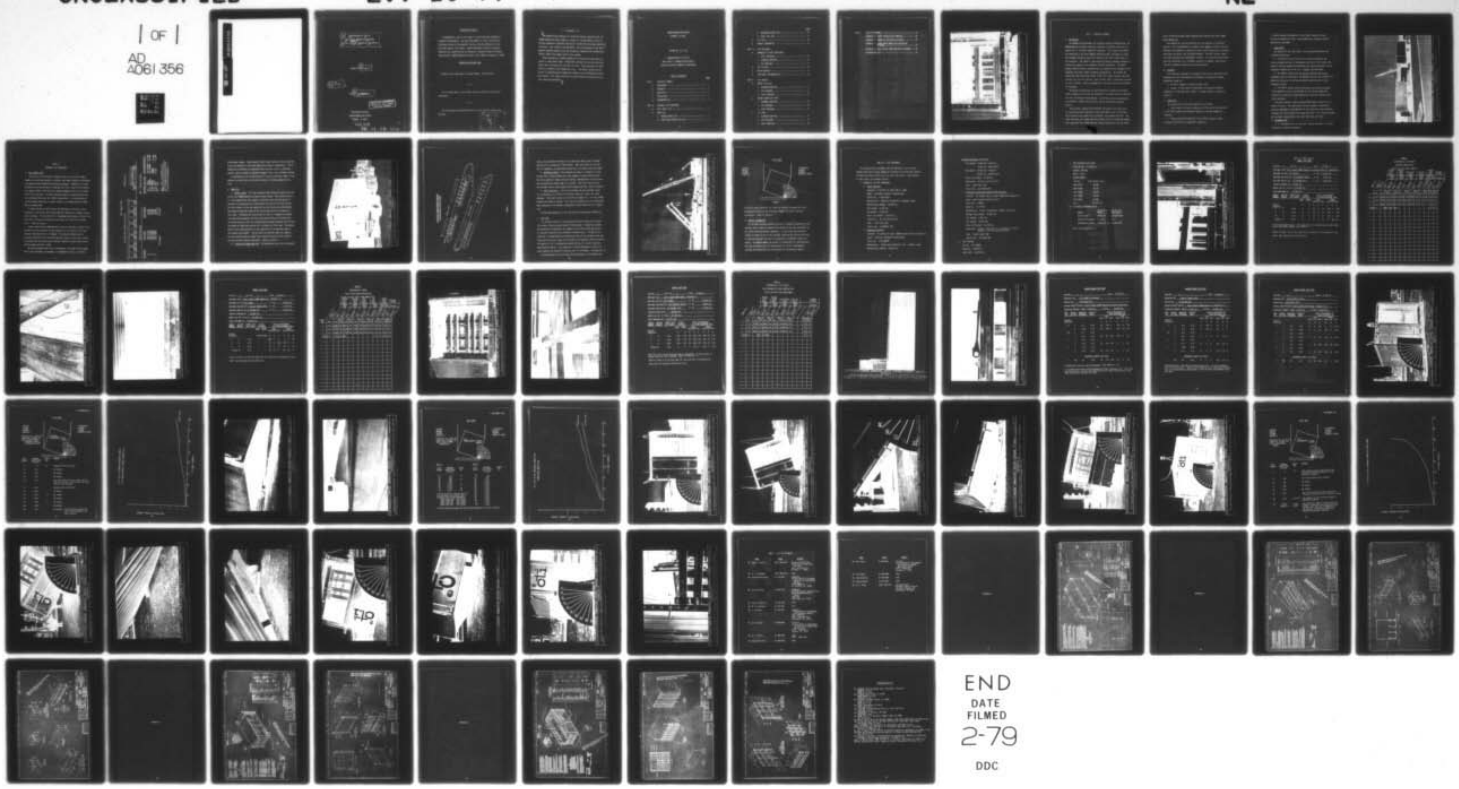

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TRANSPORTABILITY TEST OF NAVY IRSKIT AMMUNITION RESTRAINT SYSTEM IN 20-FOOT COMMERCIAL CONTAINERS

(14)

REPORT NO. EVT-10-77

(12) 44 p.

(11)

DATED: 1 SEPTEMBER 1977

EVALUATION DIVISION

DARCOM AMMUNITION CENTER

SAVANNA, ILLINOIS

410 008

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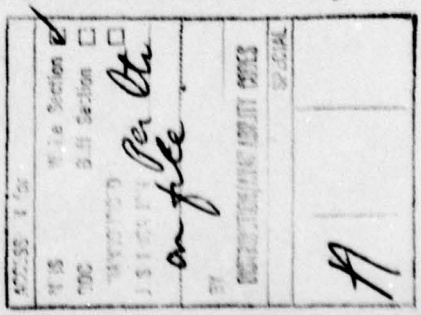

* * * ABSTRACT * * *

The DARCOM Project Manager for Container Systems requested that the DARCOM Ammunition Center conduct a series of transportability tests on 20-foot commercial containers employing a system which provides ammunition restraint. This system is called IRSKIT and was developed by the Naval Weapons Handling Center, which had previously conducted the container-on-flatcar (COFC) rail impact test of this system.

Three containers of varying materials of construction were each subjected to three modal tests. These tests include the trailer-on-flatcar impact test, the road test, and the tilt test. Each container was loaded with a different inert ammunition item. The IRSKIT system was successful in restraining the ammunition lading in all configurations which were tested. This report describes the test program and analyzes the results that were generated.

DARCOM AMMUNITION CENTER

SAVANNA, ILLINOIS

REPORT NO. EVT 10-77

TRANSPORTABILITY TESTS OF NAVY IRSKIT 12 AMMUNITION RESTRAINT SYSTEM IN 20-FOOT COMMERCIAL CONTAINERS

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PHOTOGRAPH NO. 1

This photograph shows the inert 155MM SLP loaded-alumunum container with IRSKIT restraint system prior to commencement of the rail impact test.

PART I - EXECUTIVE SUMMARY

A. BACKGROUND

The DARCOM Project Manager for Container Systems requested that the DARCOM Ammunition Center evaluate a method of providing restraint for ammunition in a 20-foot commercial container. This system, the IRSKIT, was developed by the Naval Weapons Handling Center and employs a cable and bulkhead system to secure the lading to the front corner posts of the container. The IRSKIT is the latest of several alternate methods of restraining ammunition in commercial 20-foot containers. The Naval Weapons Handling Center conducted the rail impacting test program of the Container-on-Flatcar (COFC) shipping configuration. This Center was tasked with the Trailer-on-Flatcar (TOFC) rail impact testing, the road testing, and the tilt testing. Each of these tests is necessary in order to ship a specific family of ammunition items over each of the transportation modes.

The Bureau of Explosives of the Association of American Railroads (AAR) attended the test and was responsible for making approval decisions for rail and highway transportation. The US Coast Guard representative was present to observe the tilt test results and perform approval duties.

Three 20-foot commercially-available containers of various types of construction were subjected to the three modal tests listed above. Each container was loaded with a different inert ammunition item. The steel container was loaded with MK 82 bombs, while its aluminum counterpart contained inert 155MM separate loading projectiles, and the fiber-

glass-reinforced-plywood (FRP) container was stuffed with inert 105MM boxed ammunition.

Each ammunition load was monitored by five channels of electronic sensors. This instrumentation included strain gauges on each of the four threaded rod assemblies to measure restraint cable tension and a displacement gauge to monitor rear bulkhead movement. The TOFC flatcar coupler force was monitored by a dynamometer coupler. All data that are so generated are transmitted via a telemetry system to a magnetic tape record, from which automatic analysis can be accomplished.

B. AUTHORITY

This study was conducted in accordance with mission responsibilities delegated by the US Army Materiel Development and Readiness Command. Reference is made to:

1. AR 740-1, Chapter 4, Dated 4 October 1974.

2. Letter, US Army Materiel Development and Readiness Command (DRCPM-CS), 11 February 1977, subject: Internal Restraint System Kit (IRSKIT).

C. OBJECTIVES

The objectives of this test program are as follows:

1. Obtain modal (railroad, highway, and ship) approval/disapproval of the IRSKIT ammunition restraint system in a 20-foot commercial container.

2. Obtain approval/disapproval of the IRSKIT system in steel, aluminum, and FRP 20-foot commercial containers.

3. Obtain approval/disapproval of the IRSKIT system for three families of ammunition items - boxed ammunition, separate loading projectiles, and bombs.

D. CONCLUSIONS

The results of this rail impact testing program generated the following conclusions:

1. The IRSKIT system, in conjunction with the blocking and bracing systems detailed in the Appendix section of this report, was tested in 20-foot commercial containers and received approval for the shipment of ammunition in the rail, highway, and ship modes.

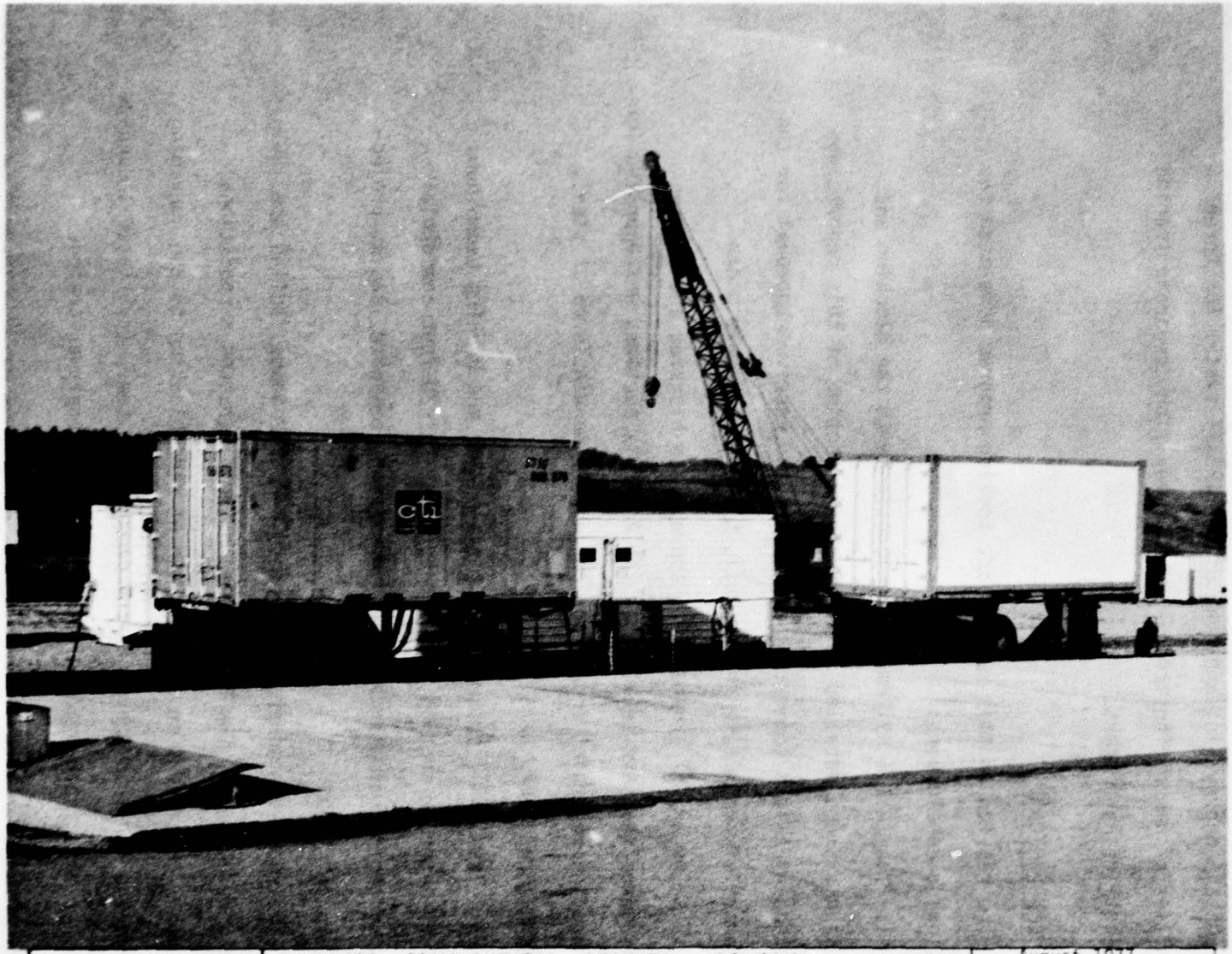
2. The IRSKIT system, with appropriate blocking and bracing procedures that are detailed in the Appendix section, was approved for ammunition restraint in 20-foot containers manufactured of steel, aluminum, and FRP.

3. The IRSKIT system, with the blocking and bracing techniques of the Appendix section, was approved for the 20-foot commercial container for shipping of boxed ammunition, separate loading projectiles, and bombs.

The steel container, which contained MK82 bombs, failed the 80 degree tilt test. The Coast Guard official granted a conditional approval contingent on the addition of side blocking to the dunnaging procedure for this containerized ammunition item. This lateral dunnage had not been incorporated in the inert load that was tested.

E. RECOMMENDATION

It is recommended that the container loading procedures as tested be adopted as approved procedures.



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PHOTOGRAPH NO. 2

The aluminum container and the fiberglass reinforced plywood (FRP) container are shown in the trailer-on-flatcar (TOFC) mode prior to the rail impact test.

PART II

APPROVAL TEST PROCEDURES

A. RAIL IMPACT TEST

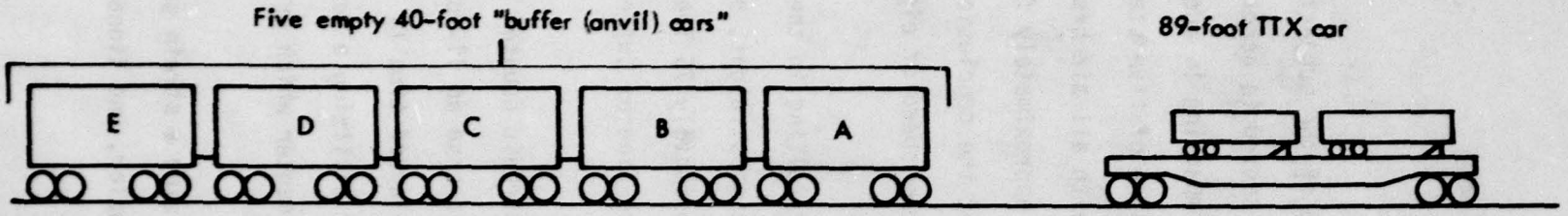
The test car (a TTX flatcar loaded with up to two of the subject commercial containers mounted on chassis) was impact tested in accordance with approved and standardized testing procedures. Impacting is accomplished by striking the test or specimen car into a line of five stationary, empty "buffer" cars which are coupled together with all air brakes in the "set" position. Forward impacting speeds are approximately four, six, and eight miles per hour (MPH) consecutively. At the conclusion of the forward impacting, a reverse impact at a minumum speed of eight MPH is accomplished.

A switch engine is used to start the specimen car rolling in the direction of the buffer cars along a 300-foot segment of straight, nearly level trackage. The specimen car is disengaged approximately 75 feet from the point of impact and allowed to run freely into the line of buffer cars. Refer to Figure 1.

Impact velocities are determined by using an electronic counter which measures the time required for the specimen car to traverse an 11-foot distance immediately prior to impact. The recorded elapsed time is converted electronically into miles per hour (MPH) by utilizing a series of counters and oscillators and a digital computing counter which prints out the impact velocity in MPH.

The test specimens were fully instrumented, utilizing a strain gauge link in each threaded rod assembly, a dynamometer coupler, and linear

RAIL IMPACT TEST



BUFFER CAR DATA

Car Position	Car Number	Light Weight #
A	USAX 27179	46,000
B	USAX 27198	46,000
C	USAX 27085	46,000
D	USAX 27086	46,000
E	USAX 26033	43,900
	Total Weight	227,900 #

Direction of impact

SPECIMEN CAR DATA

TTX 155063
CAPY 130000FC
Ld LMT 135000
Lt Wt 73,400
Length 89-0
Blt 4-67

CONTAINER WEIGHTS

CTIU 2514251 - 43,610#
CTIU 068878 - 39,430#
Theurer C49834 - 45,290#
Chassis - 6,100#

Note: The 4, 6 and 8 MPH forward impacts will be on the A-end of specimen car. The 8 MPH reverse impact will be on the B-end of the specimen car.

FIGURE 1

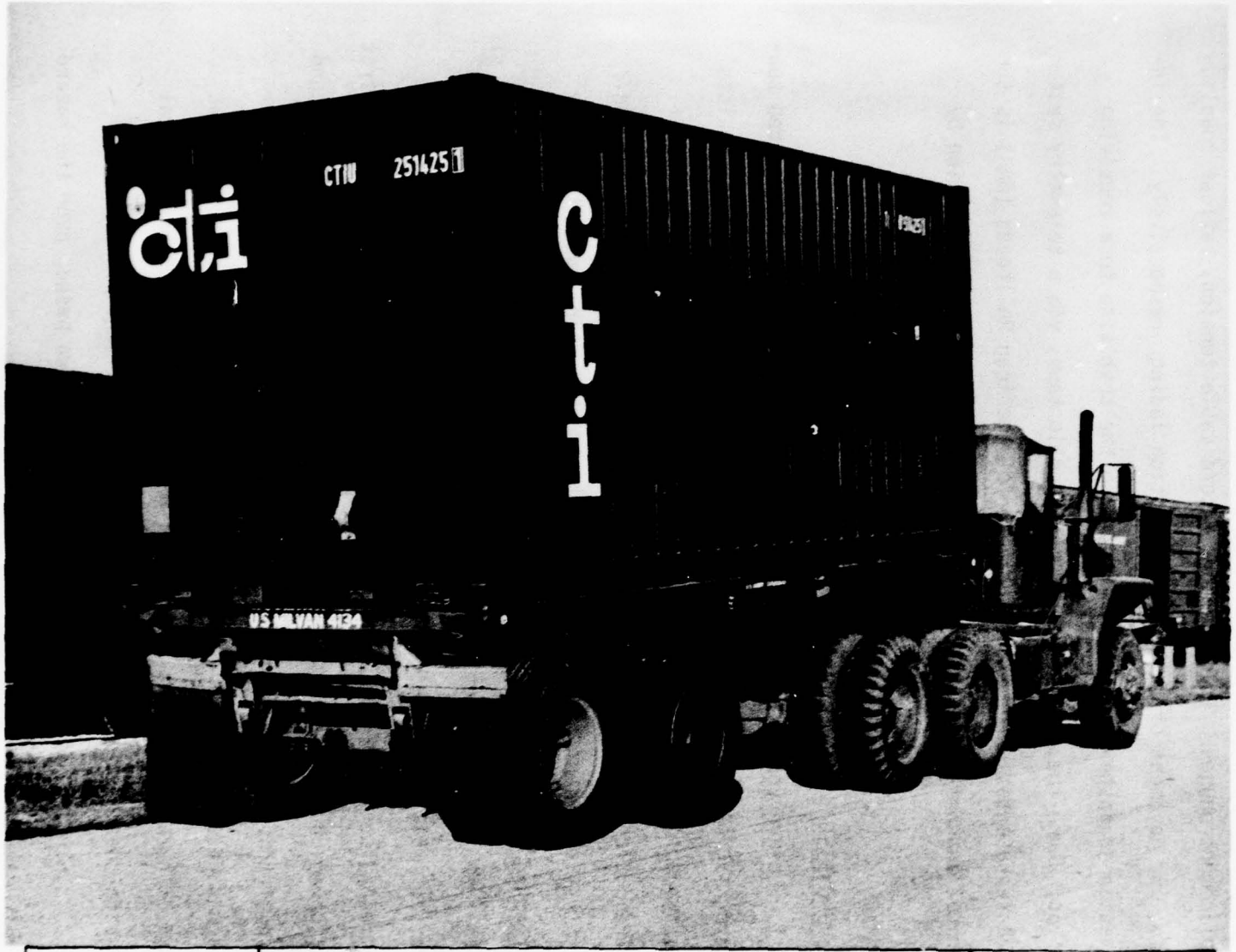
displacement gauges. These sensors record cable tension, railcar coupling force, and movement of the inert ammunition lading, respectively. The information so gathered is transmitted from the test site to a receiving station, where the data is stored on magnetic tape, via a telemetry system.

A representative of the Association of American Railroads (AAR) is the approval authority for any innovative method of shipping ammunition by rail.

B. ROAD TEST

1. Hazard Course - The test containers were placed on chassis and towed over the DARCOM Ammunition Center Hazard Course. This course consists of a two hundred foot long segment of concrete road with two series of railroad ties projecting six inches above the level of the road surface. The first series of ties are spaced on ten foot centers and alternately positioned on opposite sides of the road centerline for a distance of fifty feet. Following the first series of ties is a roadway of seventy-five feet which separates the first and second series of railroad ties. The second series of ties are alternately positioned similarly to the first but spaced on eight foot centers for a distance of fifty feet. The second phase of this step provides for the subjection of the specimen load to this hazard course again. The trailers and specimen loads are towed across the hazard course at speeds that produce the most violent vertical and side-to-side reaction obtainable. Refer to Figure 2.

2. Thirty-Mile Rough Road Test - Following two passes over the hazard



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PHOTOGRAPH NO. 3

The 20-foot steel container, with its inert MK82 bomb load, is mounted on its chassis, which is attached to a tactical tractor in advance of the road test.

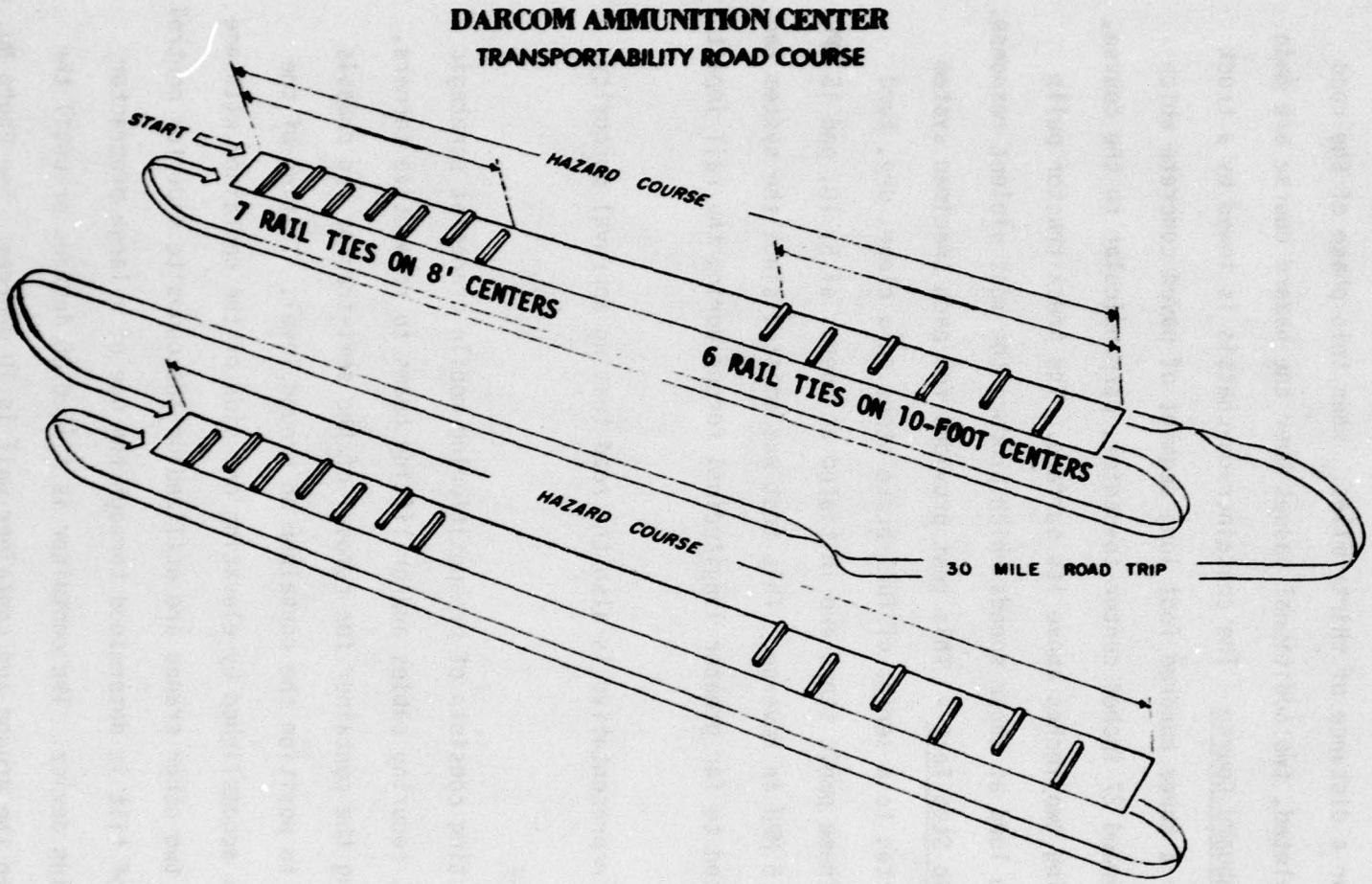

DARCOM AMMUNITION CENTER
TRANSPORTABILITY ROAD COURSE
START
HAZARD COURSE
7 RAIL TIES ON 8' CENTERS
6 RAIL TIES ON 10-FOOT CENTERS
HAZARD COURSE
30 MILE ROAD TRIP

FIGURE 2

course, the containers-on-chassis are towed over depot roads of random condition for a distance of thirty miles. When this phase of the road test is completed, two additional passes over the hazard course are made.

3. Washboard Course - The container-on-chassis is towed by a truck tractor over a three hundred foot long segment of paved concrete which has rails spaced 27 inches center-to-center, perpendicular to the course, and protruding two inches above its surface. The truck tractor pulls the specimen load at those speeds which produce the most violent response.

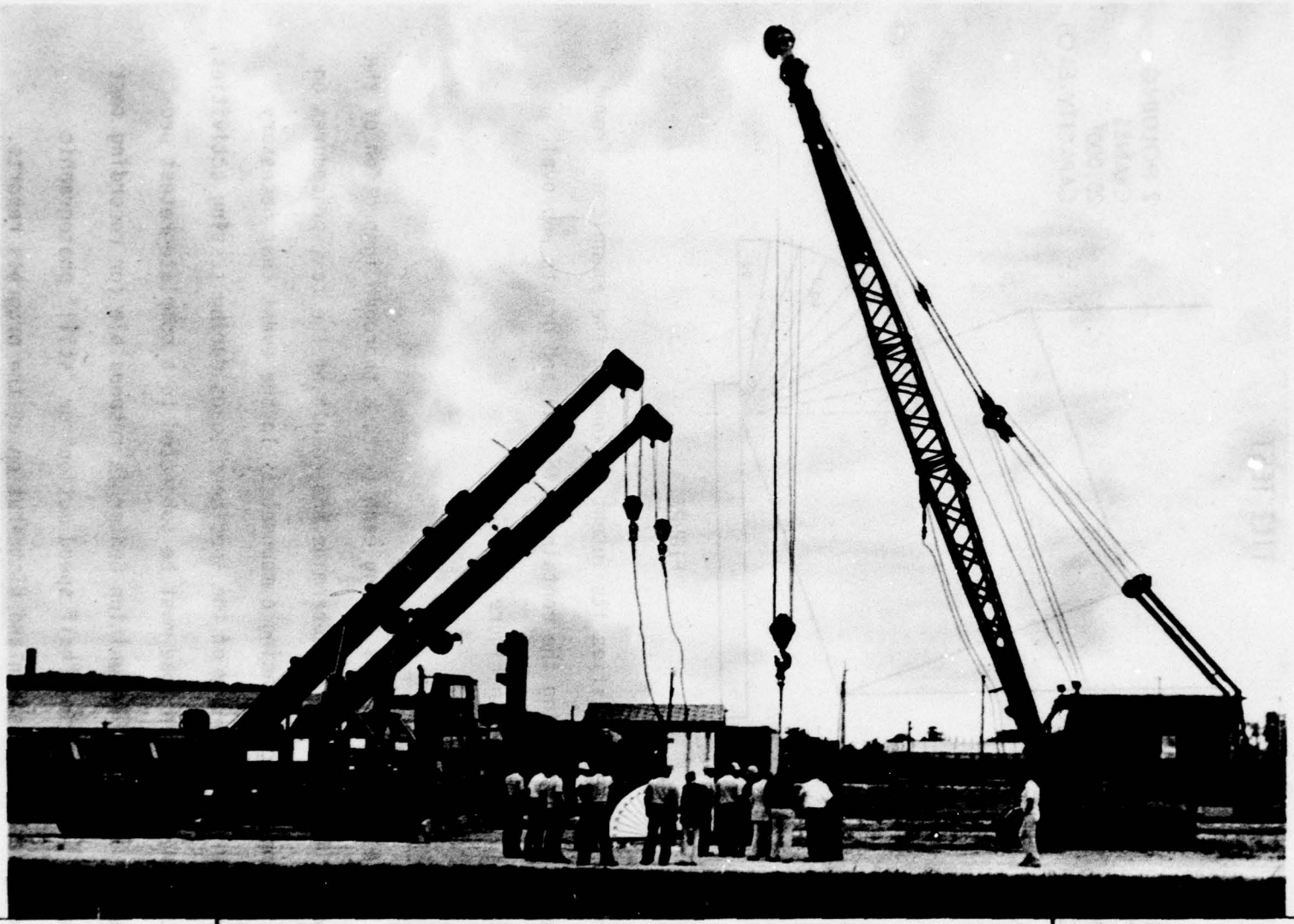
4. Panic Stop Test - This test provides for each specimen system to be subjected to a series of full-brake stops on a clear, dry, hard pavement. These panic stops are initiated at speeds of 5, 10, and 15 MPH forward and 5 MPH in reverse. This test was omitted since the system had been subjected to far greater longitudinal forces during the rail impact test.

The AAR representative is also the road testing approval authority.

C. TILT TEST

Tilt testing consists of pre-positioning mobile cranes at strategic lift points, securing cables and/or lifting beams to respective corners, and elevating the container for removal of the semi-tractor and chassis as required to position the container on ground level. Tilting of the container is accomplished by elevating one side of the container with one crane while two other cranes are utilized on the opposite side for control. The degree of tilt is determined through the use of a large protractor type measuring device. The container is tilted 80 degrees or until the angle between the ground and container wall is 10 degrees. See Photo No. 4.

A representative of the US Coast Guard determines if the ammunition



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PHOTOGRAPH NO. 4

This photograph details the 80-degree tilt test setup. The crawler crane on the right provides the initial lift, while the two mobile cranes provide support originally and then support the container when the center of gravity shifts.

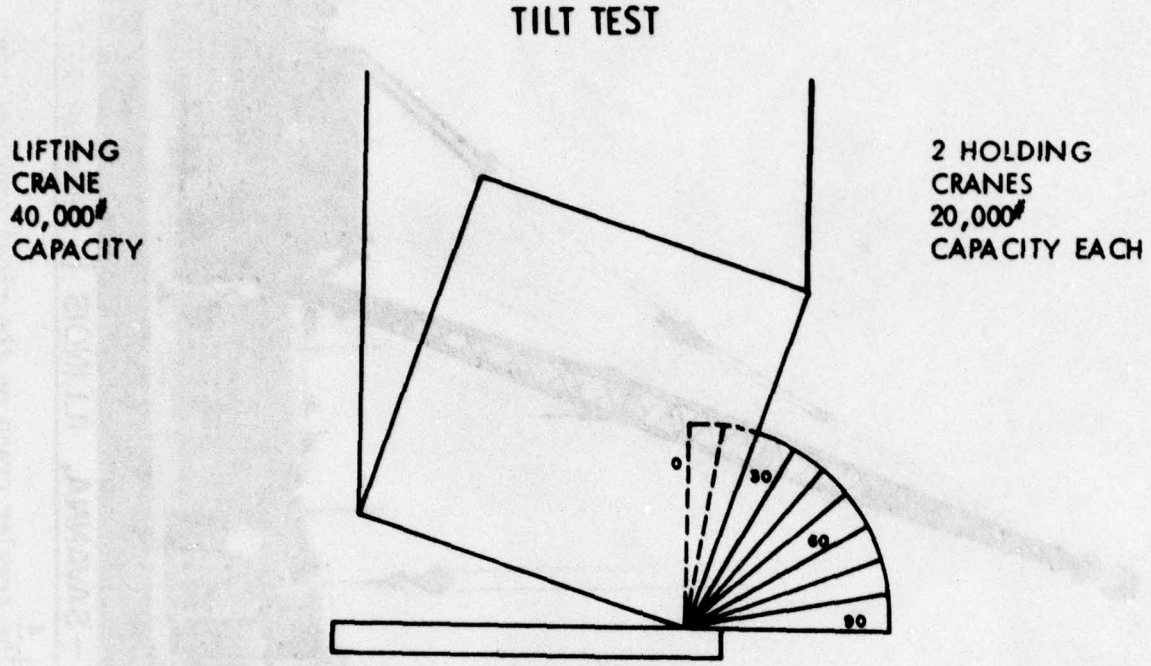

FIGURE 3

restraint system satisfies its intent of keeping the ammunition from permanently deflecting the container sidewall and grants approval accordingly. Refer to Figure 3.

D. GENERAL INFORMATION

At selected intervals during each test, a thorough inspection of the specimen load is made to determine the result of the test procedures on the lading and load bracing components. In the event that necessary changes are made to any of the speciment loads during testing activities, the altered specimen load must be subjected to a complete retest procedure. The DARCOM Ammunition Center is responsible for recording test data and for acquiring "half speed motion" or "still" photographic coverage and preparation and distribution of the progress reports.

PART III - TEST SPECIMENS

The transportation equipment that was employed in this testing program consisted of three commercial containers and associated chassis, a trailer-on-flatcar (TOFC) rail car, and five boxcars. Descriptions of these pieces of equipment follow:

A. COMMERCIAL 20-FOOT CONTAINERS

1. Steel Container

Contents: 12 pallets of inert 500-lb. bombs

Owner: Container Transport International

Serial No.: CTIU 2514251

Manufacturer: Tokyo Car Corporation, Yokohama, Japan

Maximum Gross Weight: 44,800 lbs.

Tare Weight: 5,070 lbs.

Net Weight: 39,730 lbs.

Gross Test Weight: 43,610 lbs.

Dimensions: 20'L by 8'W by 8'10"H

Cube: 1,169 cubic feet

Chassis No.: US MILVAN 4134

2. Aluminum Container

Contents: 42 pallets of inert 155MM separate loading projectiles

Owner: Container Transport International

Serial No.: CTIU 068878

Manufacturer: Kinsan Auto Industries, Ltd., Ishkawa, Japan

Maximum Gross Weight: 44,800 lbs.

Aluminum Container (continued)

Tare Weight: 4,000 lbs. (Stencil)

4,230 lbs. (Name Plate)

Net Weight: 40,800 lbs. (Stencil)

40,570 lbs. (Name Plate)

Gross Test Weight: 39,430 lbs.

Dimensions: 19'10.5"L by 8'W by 8'H

Cube: 1,095 cubic feet

Chassis No.: US MILVAN 4253

3. Fiberglass Reinforced Plywood (FRP) Container

Contents: 20 skidded units of inert 105MM boxed ammunition

Owner: Naval Weapons Handling Center

Serial No.: C49834

Model No.: PC 20-102

Manufacturer: Theurer Incorporated, Newark, New Jersey

Maximum Gross Weight: 44,800 lbs.

Tare Weight: 4,350 lbs.

Net. Weight: 40,450 lbs.

Gross Test Weight: 45,290 lbs.

Dimensions: Inside: 19'6.125"L by 7'9.375"W by 7'9.875"H
Outside: 19'10.5"L by 8'W by 8'6"H

Cube: 1,186.6 cubic feet

Chassis No.: US MILVAN 593

B. TOFC FLATCAR

Car No.: TTX 155063

Capacity: 130,000 FC

Load Limit: 135,000 lbs.

TOFC FLATCAR (continued)

Light Weight: 73,400 lbs.

Length: 89 feet

Built: 4-67

C. BUFFER BOXCARS

Car No.	Light Weight (lbs.)
USAX 27179	46,000
USAX 27198	46,000
USAX 27085	46,000
USAX 27086	46,000
USAX 26033	43,900
Total	227,900 lbs.

D. ELECTRONIC INSTRUMENTATION

Device	Calibration Range	Calibration Resistance
Strain Gauge	40,000 PSI	125,852 OHMS
Position Transducer	5 inches	N/A
Dynamometer Coupler	1,000,000 lbs.	22,000 OHMS

Refer to Photograph No. 5.

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PHOTOGRAPH NO. 5

Displacement of the right rear vertical bulkhead support was monitored by the position transducer at the right center of the photo. Tension in each of the four restraint cables was measured by strain gauges in the threaded rod assemblies (top and bottom right).

PART IV - TEST RESULTS
IMPACT TEST DATA

Load No. 1 Test No. 1 Date 30 Aug 77

Specimen Load: Inert-loaded 155MM Separate Loading Projectile (Appendix B)

Specimen Car No: TTX 155063 Lt. Wt. 73,400 lbs.

Specimen Container No. CTIU 068878 (Alum) Lt. Wt. 4,230 lbs.

Specimen Chassis No. US MILVAN 4253 Lt. Wt. 6,160 lbs.

Lading & Dunnage Wt. 35,200 lbs.

Buffer Car Wt. (5 cars) 227,900 lbs.

Total Specimen Wt. 45,590 lbs.

IMPACT NUMBER	CAR END STRUCK	IMPACT VELOCITY (MPH)	B-END VOID(IN)		TOTAL DISPLACEMENT OF A-END BULKHEAD (IN)					
			Left	Right	Left			Right		
					Long	Lat	Vert	Long	Lat	Vert
Initial Condition			0	0	0	0	0	0	0	0
1	A	3.68	.5	.5	.25	0	.25	.125	0	.375
2	A	6.52	.5	.5	.25	0	.25	.125	0	.375
3*	A	8.72	0	0	.25	0	0	.125	0	.875
4(Rev)	B	8.75	0	0	0	0	.25	0	.625	.25

*Lost displacement gauge. Left lower jam nut loosened;top horizontal member of rear gate cracked (See PHOTO 6).

Refer to Table 1 on the next page for the electronic instrumentation data which were generated during this test.

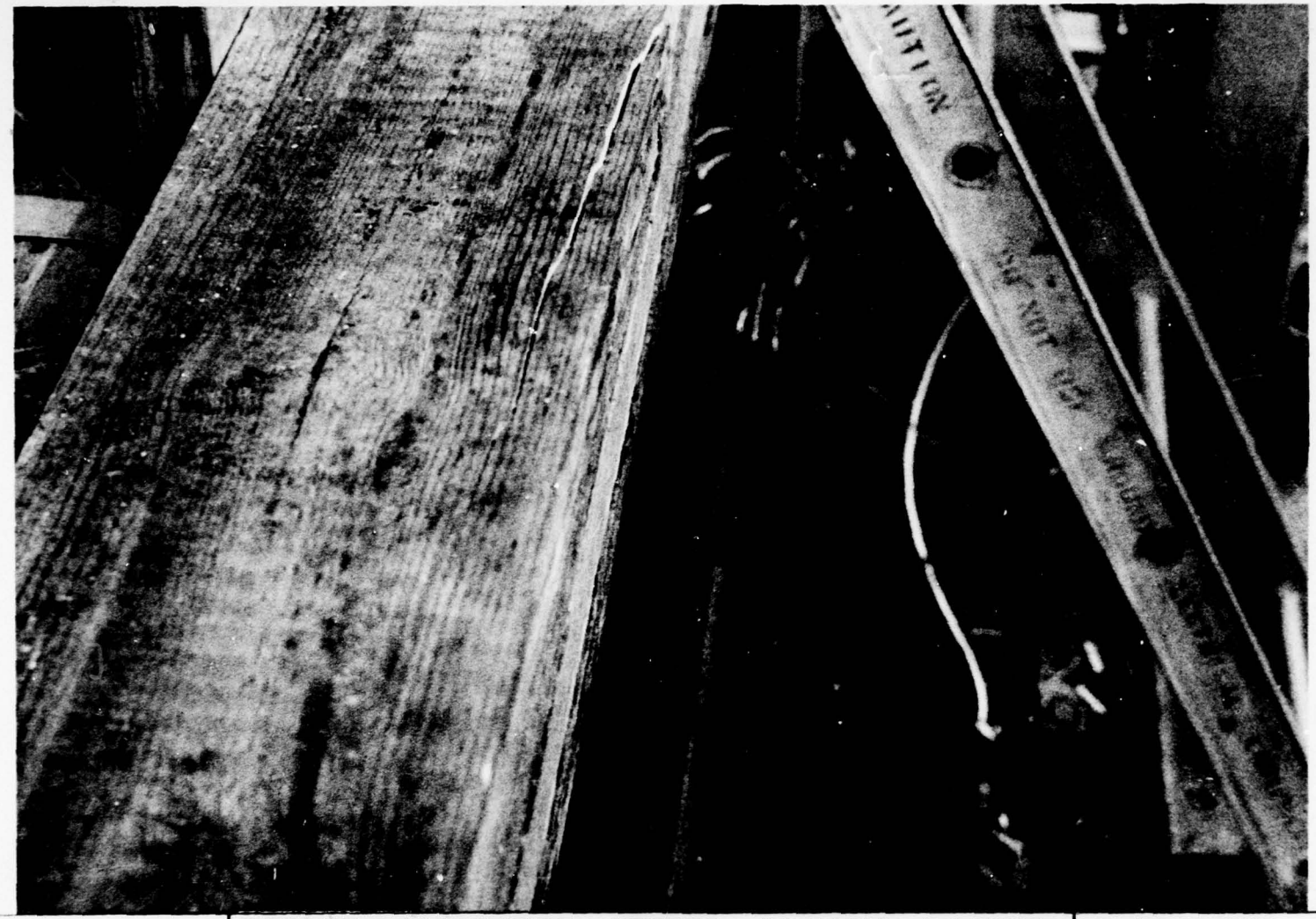
TABLE 1

CONTAINER NO. CTIU 068878

ALUMINUM CONSTRUCTION

39,430 LBS WITH INERT 155MM SLP

			BOTTOM LEFT CABLE STRAIN GAGE		BOTTOM RIGHT CABLE STRAIN GAGE		TOP RIGHT CABLE STRAIN GAGE		TOP LEFT CABLE STRAIN GAGE		CENTER REAR FLOOR DISPLACE-MENT GAGE		DYNAMO-METER COUPLER	
IMPACT NO.	IMPACT VELOCITY	FORCE	DURATION	FORCE	DURATION	FORCE	DURATION	FORCE	DURATION	FORCE	DURATION	DISPLACEMENT	DURATION	FORCE	DURATION
	MPH	LBS	MILLI SEC	LBS	MILLI SEC	LBS	MILLI SEC	LBS	MILLI SEC	LBS	INS	MILLI SEC	1000 LBS	MILLI SEC
1	3.68	12700	416	12500	208	14500	364	10800	380	0.40	450	160	110	
2	6.52	20700	366	17500	270	22100	400	15700	214	1.25	450	220	110	
3	8.72	25800	336	20600	230	27500	420	19300	260	1.80	--	620	90	
4(Rev)	8.57	CABLES WENT SLACK								--	--	440	110	



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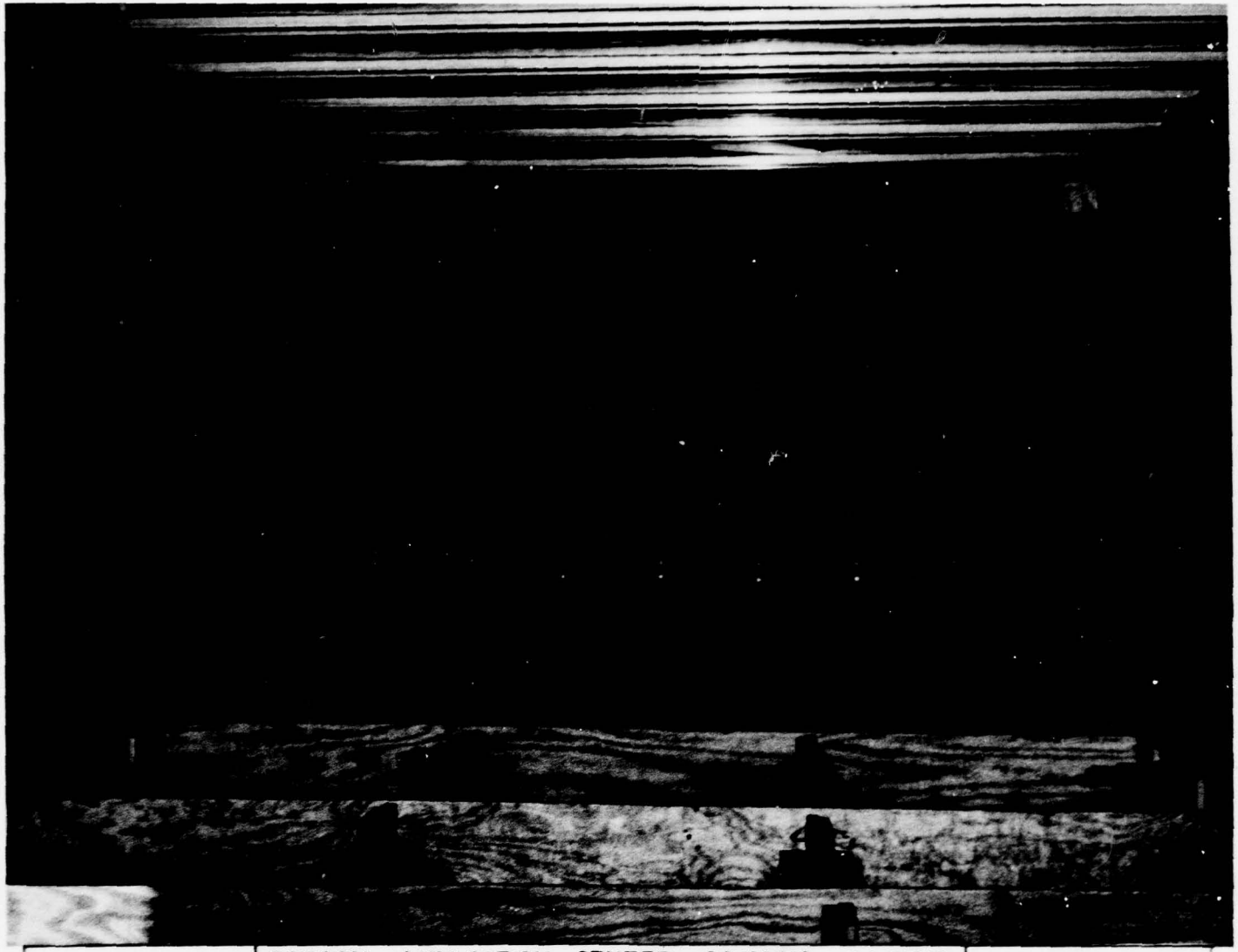
PHOTOGRAPH NO. 6

During the 8.72 MPH forward rail impact of the aluminum container, the rear bulkhead experienced a cracked top member due to the force exerted on it by the 155MM separate loading projectiles (SLP).



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PHOTOGRAPH NO. 7

This interior view of the forward end of the aluminum container shows a portion of the forward bulkhead and the tie-down points for the restraint cables.

IMPACT TEST DATA

Load No. 2 Test No. 1 Date 30 Aug 77

Specimen Load: Inert-loaded 105MM Ammunition (Appendix C)

Specimen Car No: TTX 155063 Lt. Wt. 73,400 lbs.

Specimen Container No. Theurer C49834 (FRP) Lt. Wt. 4,350 lbs.

Specimen Chassis No. US MILVAN 593 Lt. Wt. 6,160 lbs.

Lading & Dunnage Wt. 40,940 lbs.

Buffer Car Wt. (5 cars) 227,900 lbs.

Total Specimen Wt. 51,450 lbs.

IMPACT NUMBER	CAR END STRUCK	IMPACT VELOCITY (MPH)	B-END VOID(IN)		TOTAL DISPLACEMENT OF A-END BULKHEAD (IN)					
			Left	Right	Left			Right		
					Long	Lat	Vert	Long	Lat	Vert
Initial Condition			Inaccessible		0	0	0	0	0	0
1	A	3.68	"	"	.0625	0	0	0	0	.25
2	A	6.52	"	"	.25	0	.1875	.125	0	0
3	A	8.72	"	"	.25	0	.25	.25	0	.25
4 (Rev)	B	8.57	"	"	-.25	.25	0	-.50	.25	0

Refer to Table 2 on the next page for the electronic instrumentation data which were generated during this test.

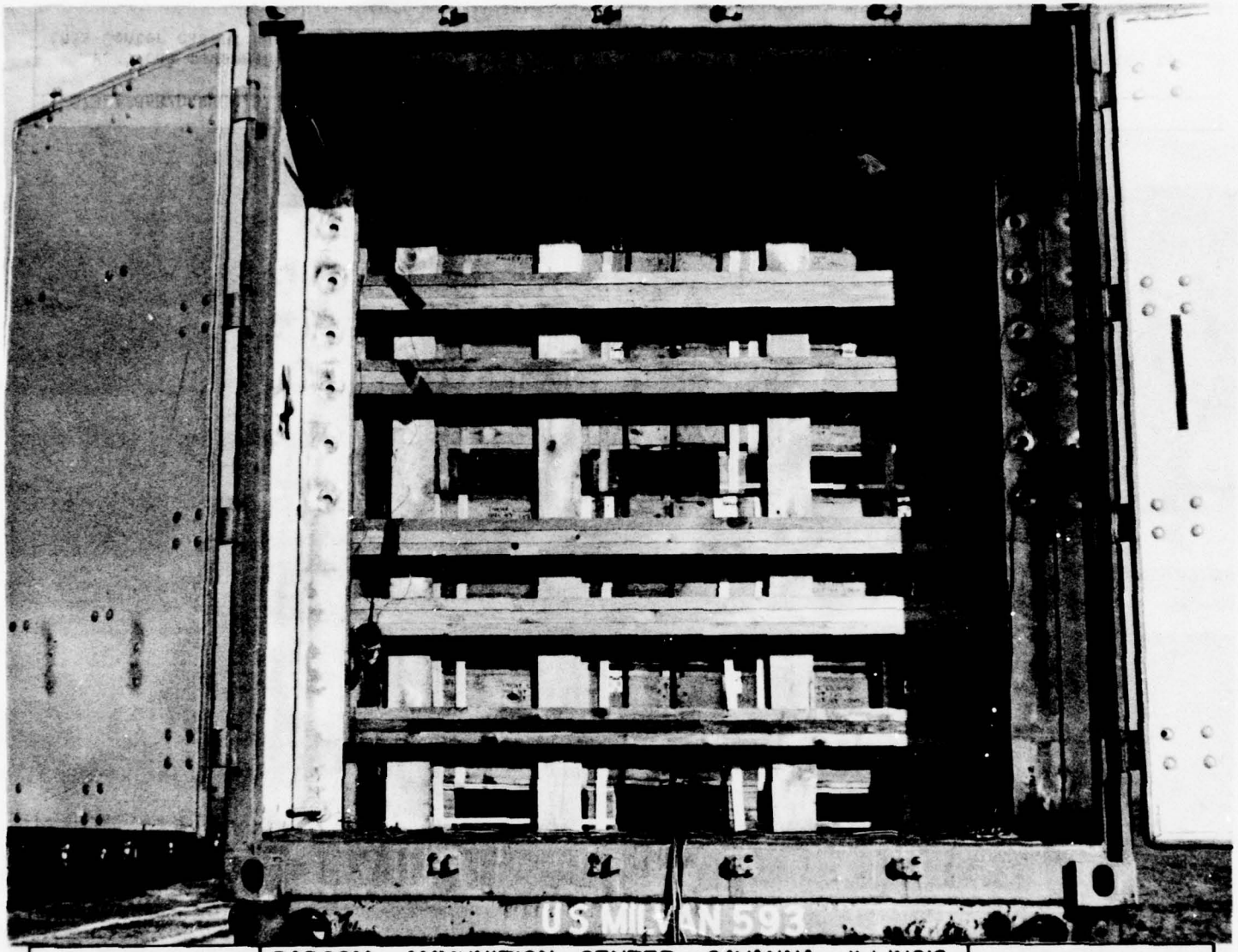
TABLE 2

CONTAINER NO. C49834

WHITE FRP/PLYWOOD CONSTRUCTION

45,290 LBS WITH INERT 105MM AMMUNITION

			BOTTOM LEFT CABLE STRAIN GAGE		BOTTOM RIGHT CABLE STRAIN GAGE		TOP RIGHT CABLE STRAIN GAGE		TOP LEFT CABLE STRAIN GAGE		CENTER REAR FLOOR DISPLACE-MENT GAGE		DYNAMO-METER COUPLER	
IMPACT NO.	IMPACT VELOCITY MPH	FORCE LBS	DURATION Milli Secs	FORCE LBS	DURATION Milli Secs	FORCE LBS	DURATION Milli Secs	FORCE LBS	DURATION Milli Secs	FORCE LBS	DISPLACEMENT INS	DURATION Milli Secs	FORCE 1000 LBS	DURATION Mill Secs
1	3.68	15880	507	10000	354	6600	764	10330	280	0.40	430	160	110	
2	6.52	16760	346	12250	486	9800	208	15430	299	1.08	440	220	110	
3	8.72	17980	344	13000	422	12800	666	13630	240	1.55	370	620	90	
4(Rev)	8.57	SLACK IN CABLES								-0.22	350	440	100	



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PHOTOGRAPH NO. 8

The FRP container with its payload of inert 105MM boxed ammunition presents a high profile and requires that the threaded rod assemblies be secured at the top of the rear vertical posts.

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PHOTOGRAPH NO. 9

Vertical movement of the inert MK82 bomb load during transit from the Naval Weapons Handling Center to this Center caused this slight nail pullout in the sway bracing dunnage.

IMPACT TEST DATA

Load No. 3 Test No. 2 Date 31 Aug 77

Specimen Load: Inert-loaded MK82 Bombs (Appendix D)

Specimen Car No: TTX 155063 Lt. Wt. 73,400 lbs.

Specimen Container No. CTIU 2514251 (Steel) Lt. Wt. 5,070 lbs.

Specimen Chassis No. US MILVAN 4134 Lt. Wt. 6,160 lbs.

Lading & Dunnage Wt. 38,540 lbs.

Buffer Car Wt. (5 cars) 227,900 lbs.

Total Specimen Wt. 49,770 lbs.

IMPACT NUMBER	CAR END STRUCK	IMPACT VELOCITY (MPH)	B-END VOID(IN)		TOTAL DISPLACEMENT OF A-END BULKHEAD (IN)					
			Left	Right	Left			Right		
					Long	Lat	Vert	Long	Lat	Vert
Initial Condition			0	0	0	0	0	0	0	0
1	A	4.21	1.00	1.00	.25	.625	1.25	.375	.25	1.25
2	A	5.58	1.00	1.00	.25	.625	1.25	.375	.25	1.25
3	A	8.45	1.00	1.00	.25	.625	1.25	.375	.25	1.25
4(Rev)*	B	8.62	0	0	0	.375	0	.125	0	1.25

*The front wall of the container had an approximate .5-inch bow due to contact with the front bulkhead. Refer to PHOTO No. 10.

Refer to Table 3 on the next page for the electronic instrumentation data which was generated during this test.

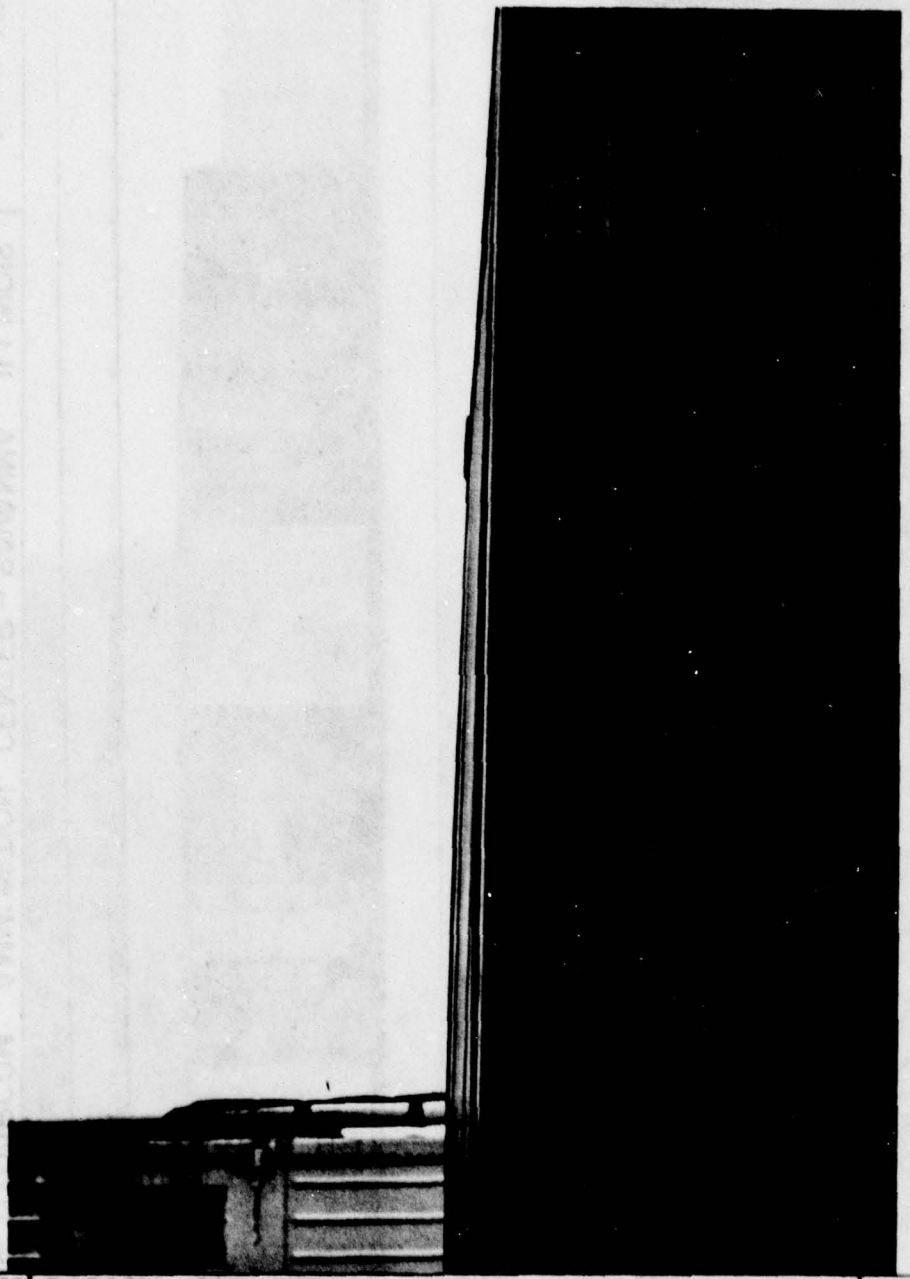
TABLE 3

CONTAINER NO. CTIU 251425 1

RED CONTAINER OF STEEL CONSTRUCTION

43,610 LBS WITH INERT MK82 BOMBS

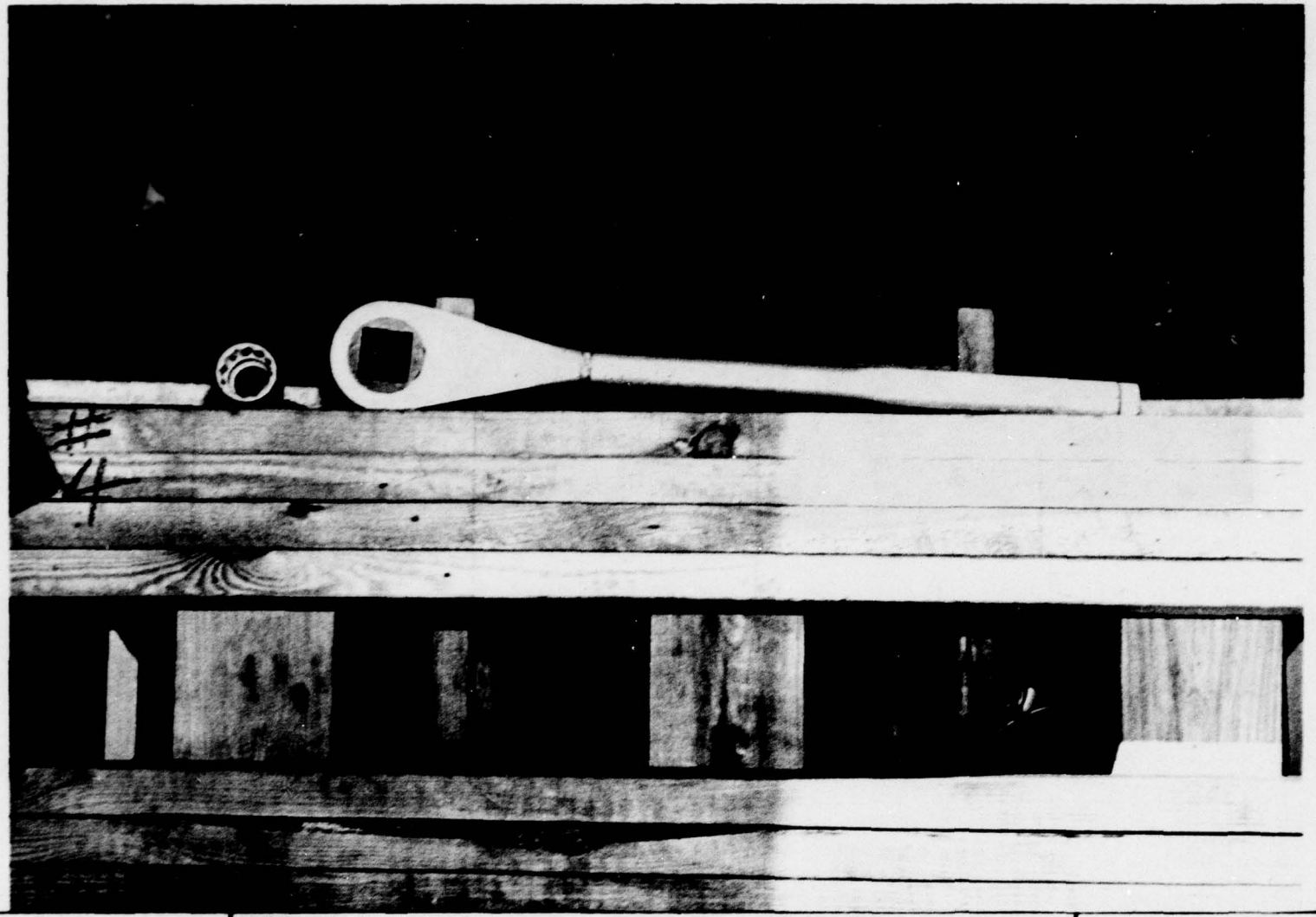
			BOTTOM LEFT CABLE STRAIN GAGE		BOTTOM RIGHT CABLE STRAIN GAGE		TOP RIGHT CABLE STRAIN GAGE		TOP LEFT CABLE STRAIN GAGE				DYNAMOMETER COUPLER	
IMPACT NO.	IMPACT VELOCITY		FORCE	DURATION	FORCE	DURATION	FORCE	DURATION	FORCE	DURATION			FORCE	DURATION
	MPH		LBS	MILLI SEC	LBS	MILLI SEC	LBS	MILLI SEC	LBS	MILLI SEC			1000 LBS	MILLI SEC
1	4.21		11600	250	18500	334	15500	245	19900	380			170	75
2	5.58		20700	370	26100	456	19700	284	25600	470			260	90
3	8.45		22500	480	29900	358	19800	278	30300	350			560	80
4(Rev)	8.62		SLACK IN CABLES										390	70



11-078-1260/DARCOM 77	DARCOM AMMUNITION CENTER – SAVANNA, ILLINOIS	August 1977

PHOTOGRAPH NO. 10

Following the reverse rail impact of the steel container with the inert MK82 bomb load, the front wall of the container showed evidence of an approximate .5 inch outward deformation from contact with the forward bulkhead.



11-078-1259/DARCOM 77	DARCOM AMMUNITION CENTER – SAVANNA, ILLINOIS	August 1977

PHOTOGRAPH NO. 11

This wrench and socket set are employed to apply or remove tension from the restraint cables of the IRSKIT 12 system.

HAZARD COURSE TEST DATA

Load No. 1 Date. 31 Aug 77

Container No. CTIU 068878 (Aluminum)

Chassis No. US MILVAN 4253

Lading Identification Inert-loaded 155MM Separate Loading Projectiles

Container Weights: Empty 4,230 lbs. Lading 35,200 lbs.

PASS NO.	SERIES OF TIES	DURATION (SECONDS)	VELOCITY (MPH)	TOTAL DISPLACEMENT AT REAR BULKHEAD (IN)					
				Left			Right		
				Long	Lat	Vert	Long	Lat	Vert
Initial Condition				0	0	0	0	0	0
1*	1	5.7	5.97	.25	.375	0	.125	.125	.125
	2	5.95	5.72	.25	.375	0	.125	.125	.125
2**	1	5.7	5.97						
	2	6.0	5.67	.25	.50	.375	.125	0	.25
3	1	5.53	6.16						
	2	5.94	5.73	.25	.50	.375	0	0	.50
4	1	6.05	5.61						
	2	5.92	5.75	.25	.50	.375	0	0	.50
WASHBOARD COURSE TEST DATA									
1	NA	69	2.96	.25	.50	.375	.25	0	.50

* Bottom left jam nut loose;retightened. (See PHOTO No. 11)

** .5-inch void between front bulkhead and front container wall. This void had decreased to .25-inch following the 30-mile rough road portion of the Road Test, which followed this pass.

HAZARD COURSE TEST DATA

Load No. 2 Date. 31 Aug 77

Container No. Theurer C49834 (FRP)

Chassis No. US MILVAN 593

Lading Identification Inert-loaded 105MM ammunition (Appendix C)

Container Weights: Empty 4,350 lbs. Lading 40,940 lbs.

PASS NO.	SERIES OF TIES	DURATION (SECONDS)	VELOCITY (MPH)	TOTAL DISPLACEMENT AT REAR BULKHEAD (IN)					
				Left			Right		
				Long	Lat	Vert	Long	Lat	Vert
Initial Condition				0	0	0	0	0	0
1	1	6.6	5.16	0	.125	0	.25	0	0
	2	6.0	5.67	0	.125	0	.25	0	0
2*	1	6.0	5.67						
	2	6.0	5.67	0	0	0	0	.125	0
3	1	5.9	5.77						
	2	5.9	5.77	0	0	0	.125	.125	0
4	1	5.85	5.82						
	2	5.9	5.77	0	0	0	1.25	1.25	0
WASHBOARD COURSE TEST DATA									
1	NA	60	3.41	0	0	0	1.25	1.25	0

*Following Pass 2, the top left jam nut was loose. It was retightened prior to the next pass. Marks on the container walls indicated that each rear post experienced an approximate .5-inch vertical displacement during this pass.

HAZARD COURSE TEST DATA

Load No. 3 Date. 31 Aug 77

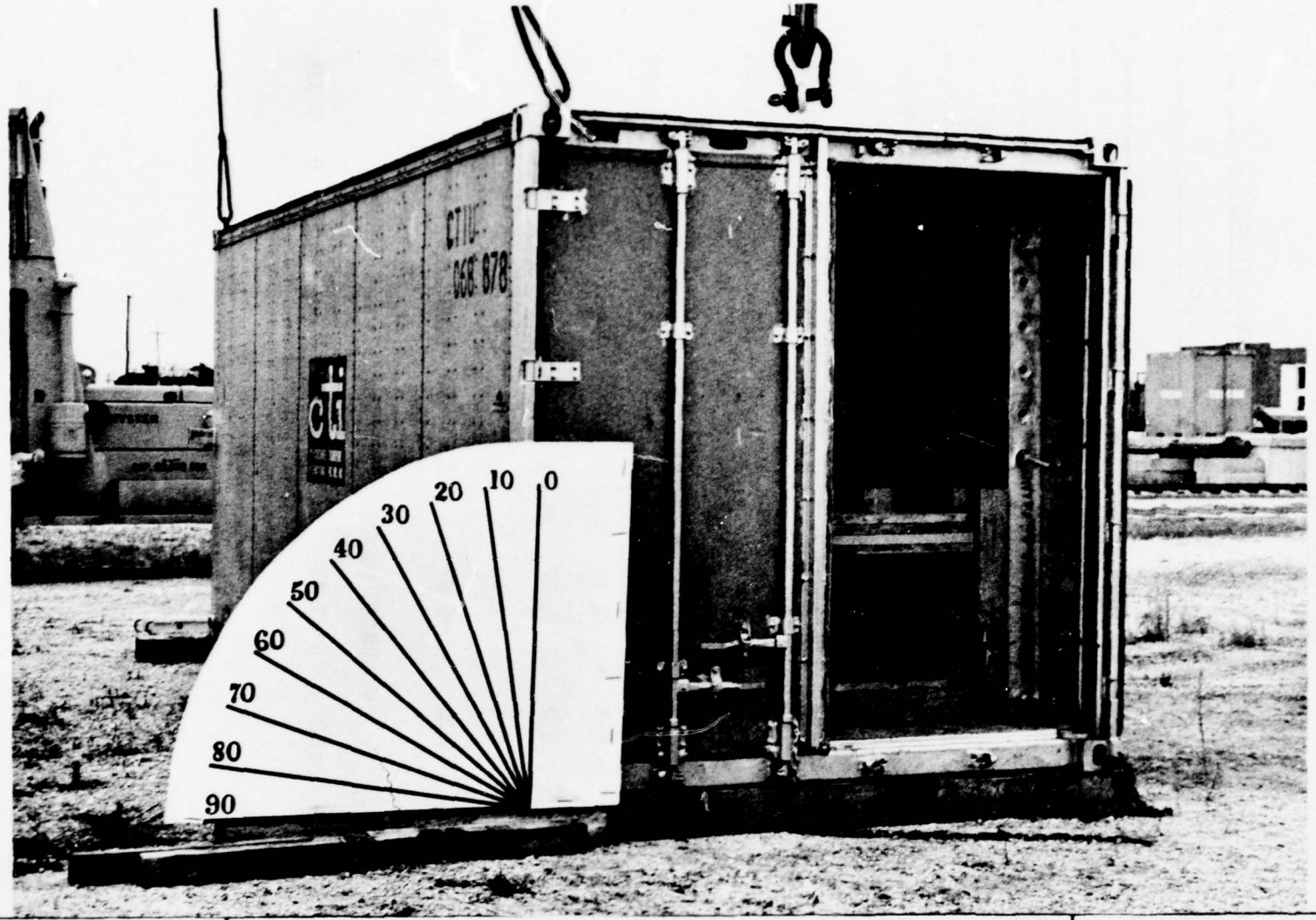
Container No. CTIU 2514251 (Steel)

Chassis No. US MILVAN 4134

Lading Identification Inert-loaded MK 82 Bombs (Appendix D)

Container Weights: Empty 5,070 lbs. Lading 38,540 lbs.

PASS NO.	SERIES OF TIES	DURATION (SECONDS)	VELOCITY (MPH)	TOTAL DISPLACEMENT AT REAR BULKHEAD (IN)					
				Left			Right		
				Long	Lat	Vert	Long	Lat	Vert
Initial Condition				0	0	0	0	0	0
1	1	5.7	5.97	0	0	.25	0	0	1.25
	2	6.0	5.67	0	0	.25	.125	0	1.375
2	1	5.7	5.96						
	2	6.0	5.67	0	0	.25	.125	0	1.375
3	1	6.6	5.16						
	2	6.0	5.67	0	.25	.375	.125	.25	1.375
4	1	6.2	5.49						
	2	6.0	5.67	0	.50	1.00	.125	.25	1.375
WASHBOARD COURSE TEST DATA									
1	NA	60	3.41	.50	.50	1.00	1.25	0	1.375



11-078-1251/DARCOM 77	DARCOM AMMUNITION CENTER – SAVANNA, ILLINOIS	September 1977

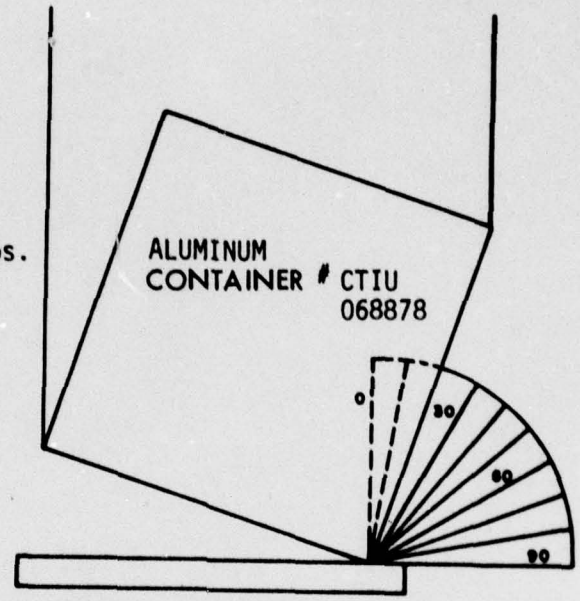
PHOTOGRAPH NO. 12

The aluminum container, filled with inert 155MM SLP, is shown prior to the tilt test.

TILT TEST

LIFTING CRANE 40,000# CAPACITY

Container Wt. 4,230 lbs.
Lading Wt. 35,200 lbs.
Inert-loaded 155MM Separate Loading Projectiles (SLP)

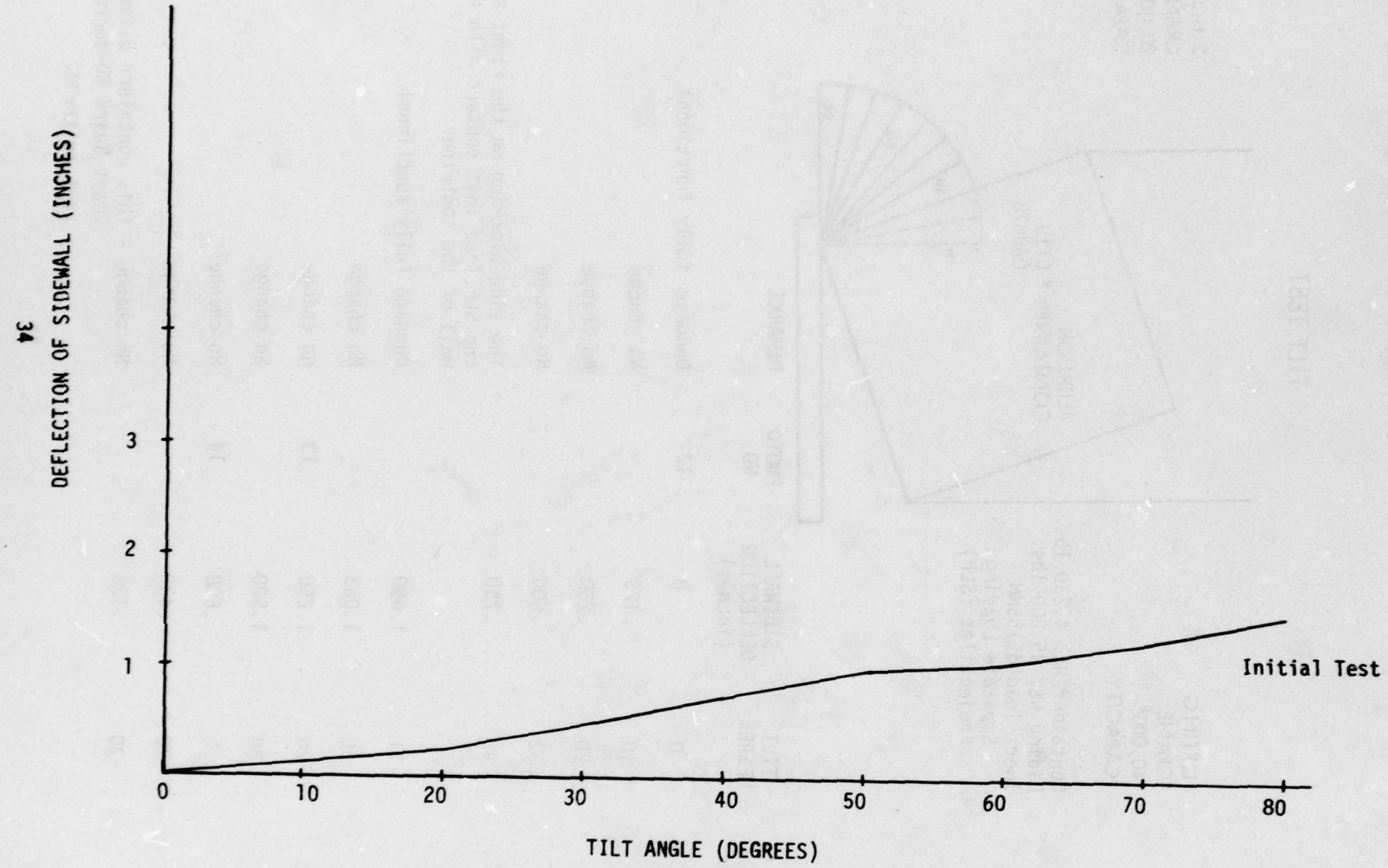


2 HOLDING CRANES 20,000# CAPACITY EACH

TILT DEGREE	SIDEWALL DEFLECTION (inches)	PHOTO NO.	REMARKS
0	0	12	Dunnage fully functional
10	.125		No change
20	.250		No change
32	.500		No change
40	.750		The side blocking on the right side of the SLP load lost contact with the right wall of the container.
51	1.000		Dunnage fully functional
60	1.063		No change
70	1.250	13	No change
80	1.500		No change
0	.688	14	No change
-20	.438		No change
-30	.125		No change - This container passed the Coast Guard 80-degree tilt test criteria.

TILT TEST OF ALUMINUM CONTAINER LOADED

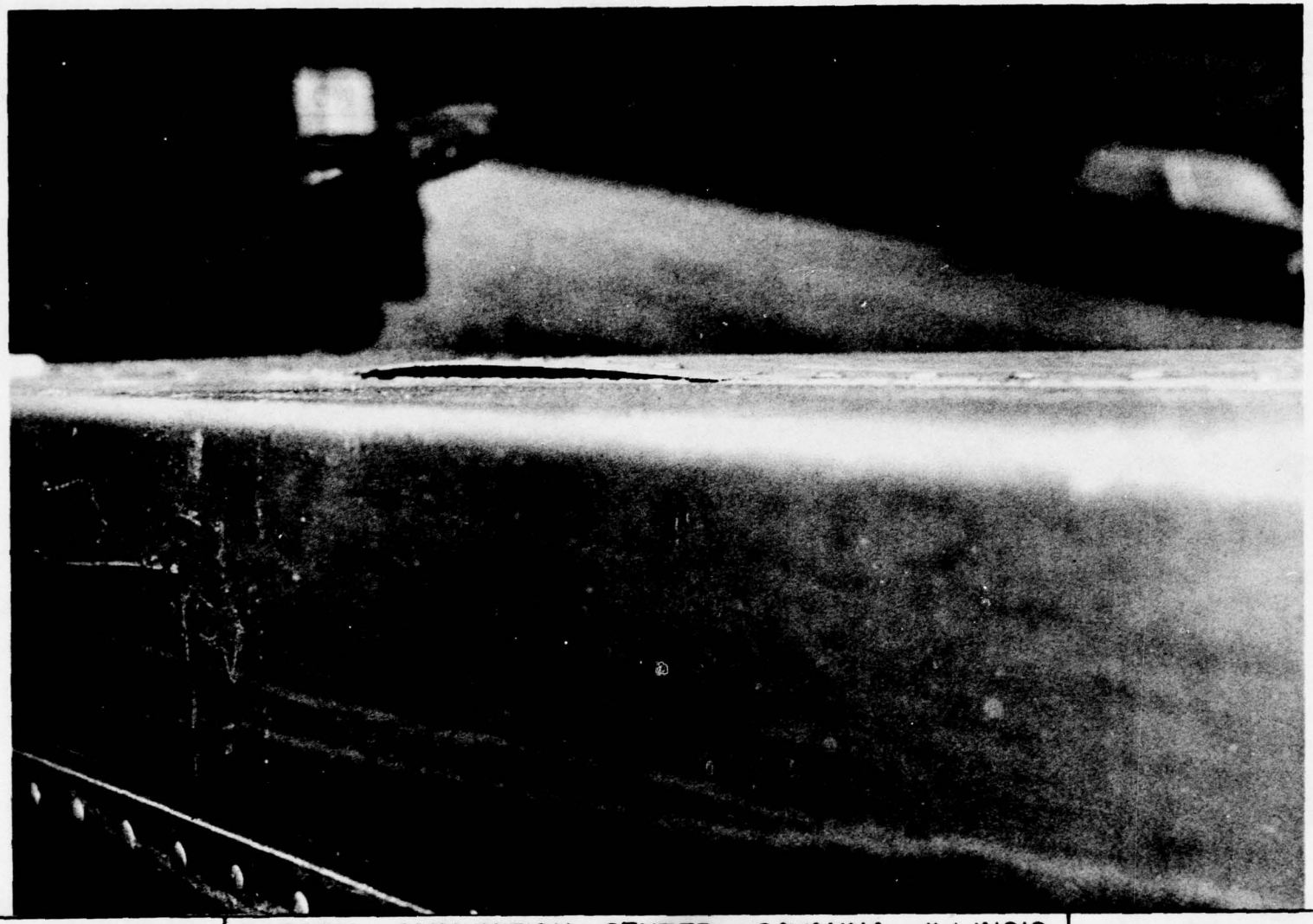
WITH 155MM SEPARATE LOADING PROJECTILES



11-078-1262/DARCOM 77	DARCOM AMMUNITION CENTER – SAVANNA, ILLINOIS	September 1977

PHOTOGRAPH NO. 13

The aluminum container is shown in the later stages of the 80-degree tilt test. The evaluation criterion is primarily the extent of container sidewall deflection.



1-078-1266/DARCOM 77	DARCOM AMMUNITION CENTER – SAVANNA, ILLINOIS	September 1977

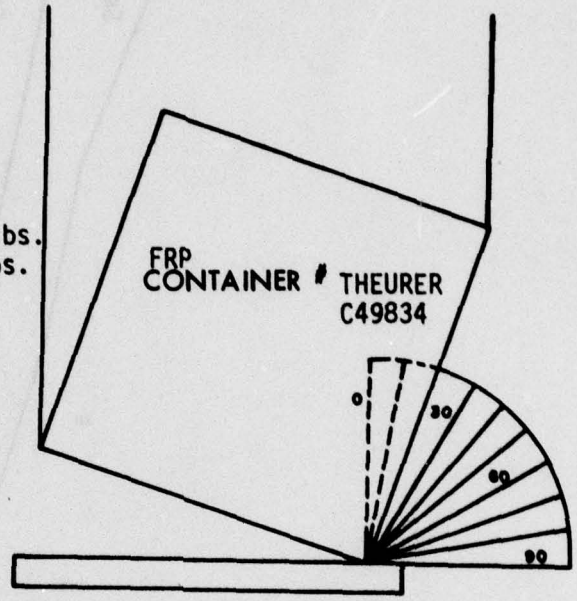
PHOTOGRAPH NO. 14

Stress present in the tilting process resulted in shearing of these roofing rivets and slight localized buckling of the roof.

TILT TEST

LIFTING CRANE 40,000# CAPACITY

Container Wt. 4,350 lbs.
Lading Wt.. 40,940 lbs.
Inert-loaded 105MM Ammunition



2 HOLDING CRANES 20,000# CAPACITY EACH

TEST 1

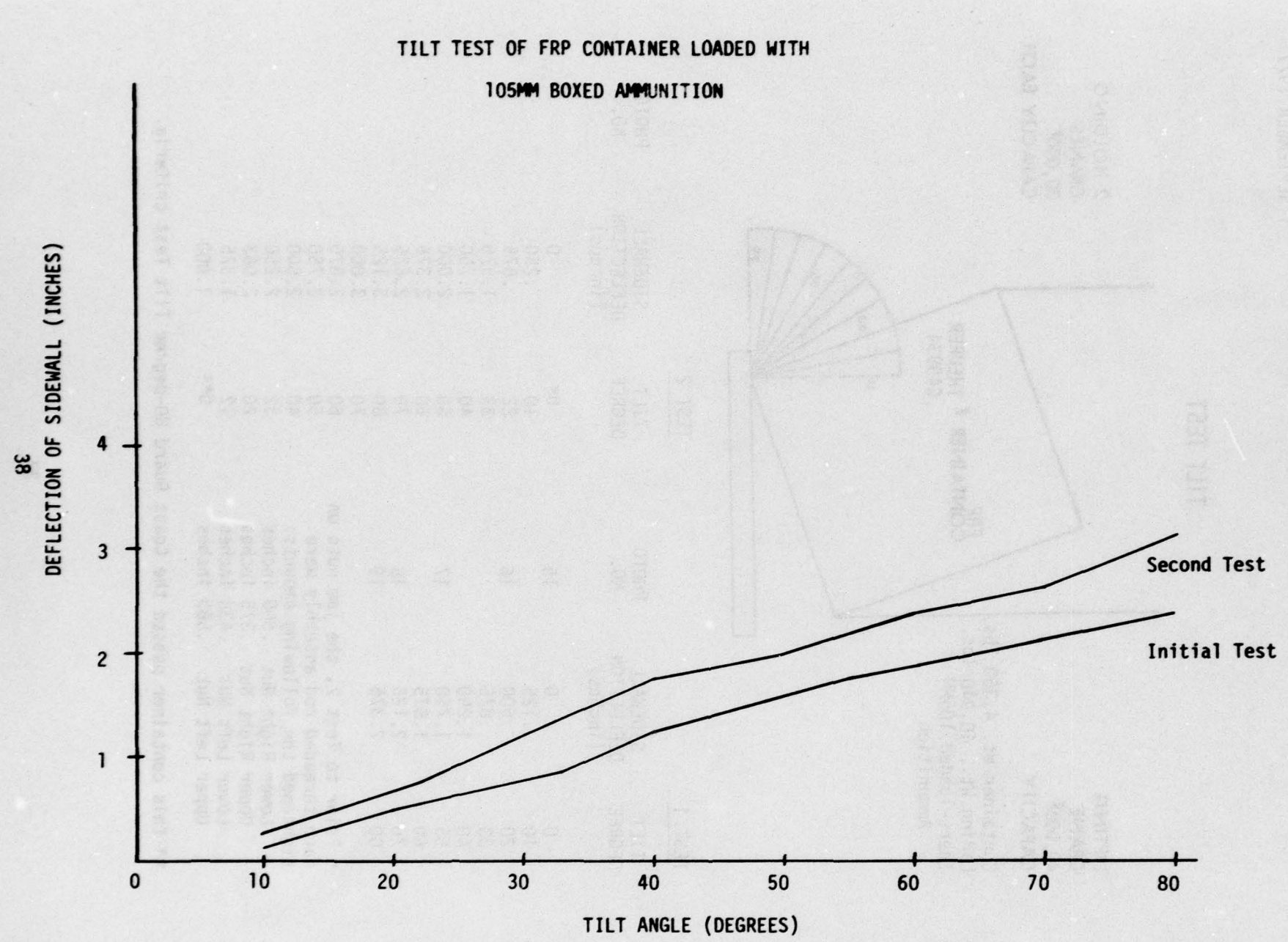
TILT DEGREE	SIDEWALL DEFLECTION (inches)	PHOTO NO.
0	0	15
10	.125	
20	.500	16
33	.875	
40	1.250	
55	1.750	17
60	1.875	
70	2.125	18
80	2.375	19

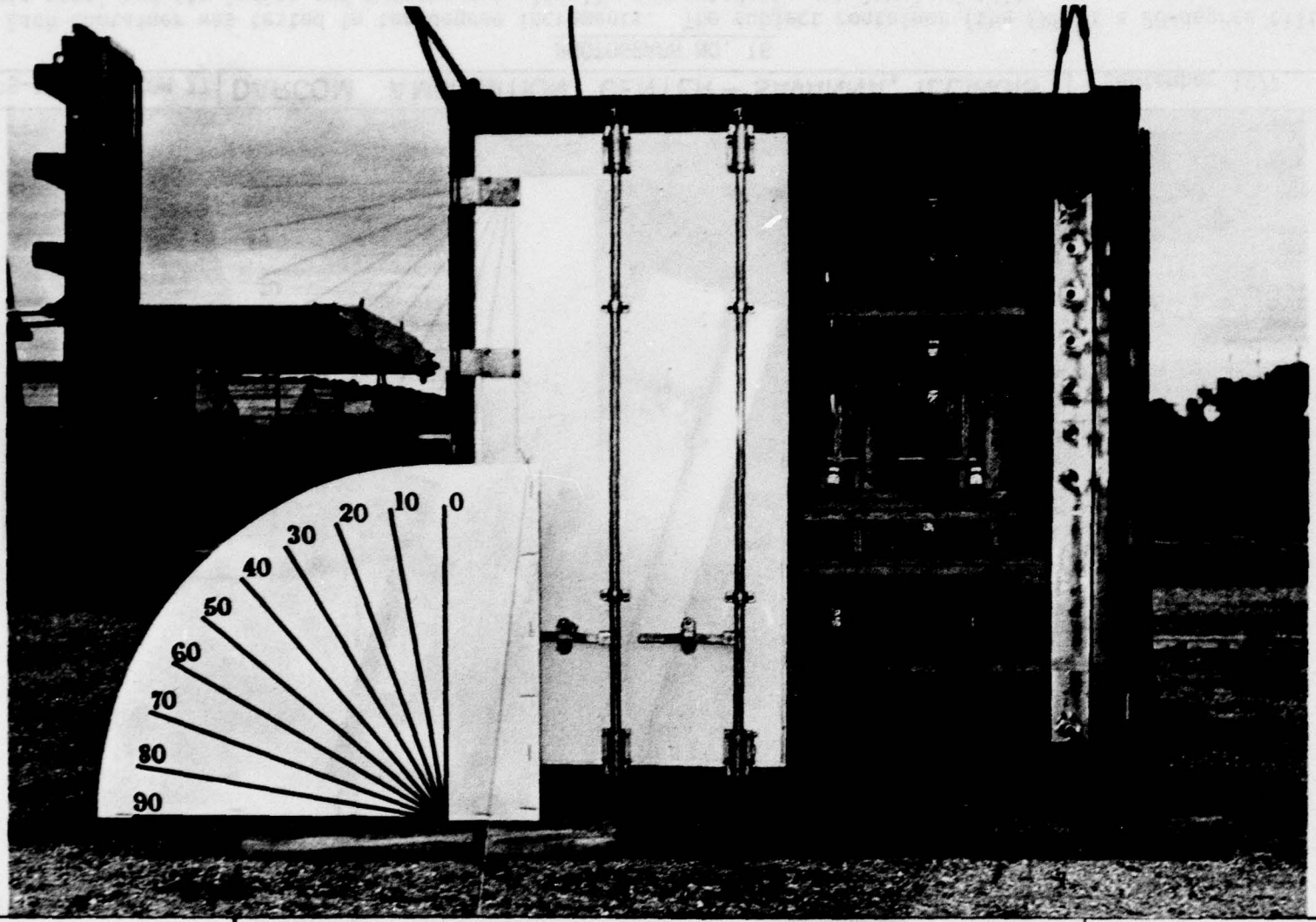
* Prior to Test 2, the jam nuts on each threaded rod assembly were tightened the following amounts:
  - Lower Right Nut .500 inches
  - Upper Right Nut .375 inches
  - Lower Left Nut .438 inches
  - Upper Left Nut .563 inches

TEST 2

TILT DEGREE	SIDEWALL DEFLECTION (inches)	PHOTO NO.
0*	0	
10	.250	
22	.875	
33	1.375	
40	1.750	
50	2.000	
60	2.375	
70	2.625	
80	3.125	
70	3.000	
60	2.875	
50	2.750	
40	2.500	
32	2.250	
20	2.063	
12	1.375	
0**	1.000	

** This container passed the Coast Guard 80-degree Tilt Test criteria.

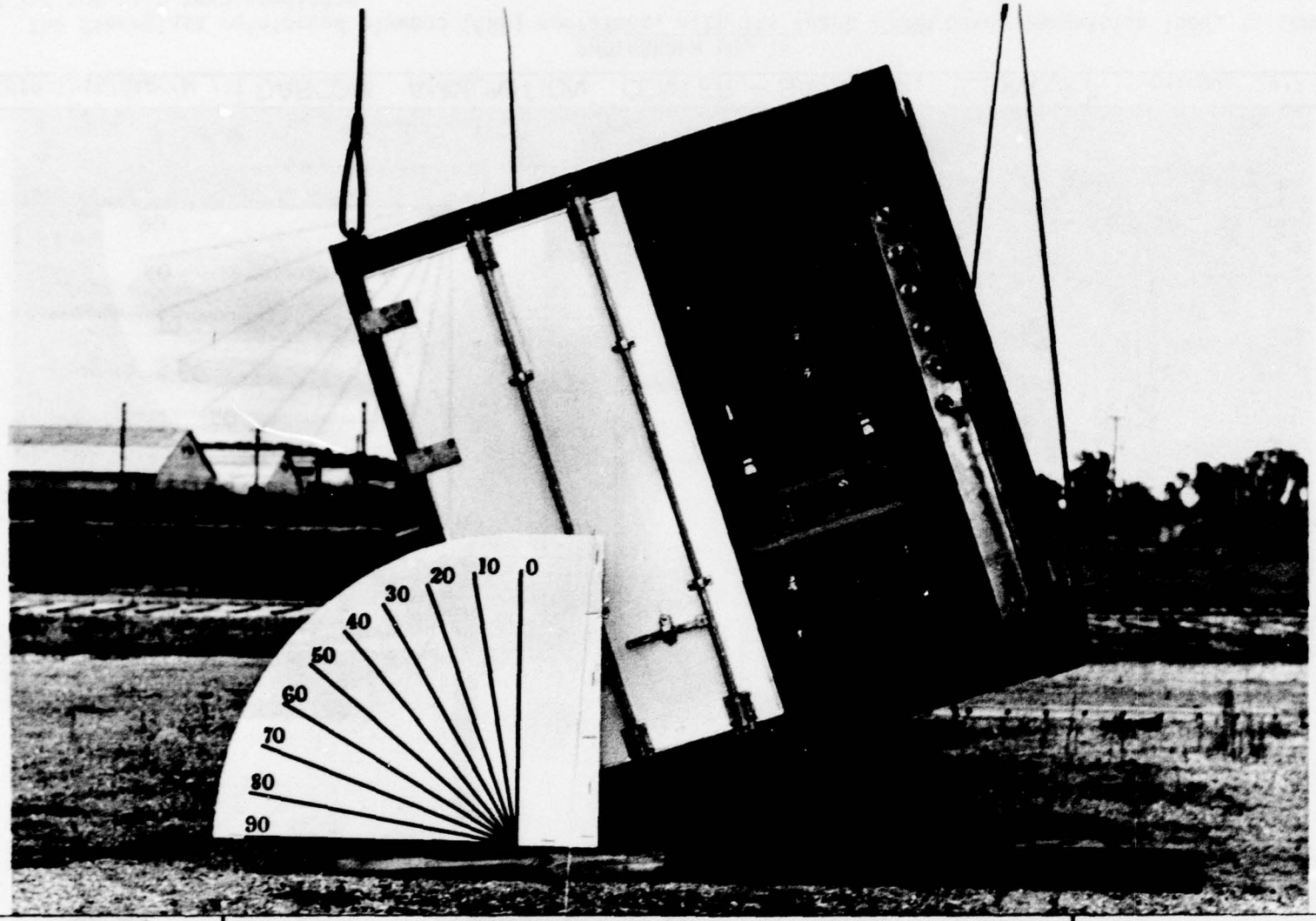

TILT TEST OF FRP CONTAINER LOADED WITH
105MM BOXED AMMUNITION
DEFLECTION OF SIDEWALL (INCHES)
38
4
3
2
1
0
10
20
30
40
50
60
70
80
TILT ANGLE (DEGREES)
Second Test
Initial Test



11-078-1245/DARCOM 77	DARCOM AMMUNITION CENTER – SAVANNA, ILLINOIS	September 1977

PHOTOGRAPH NO. 15

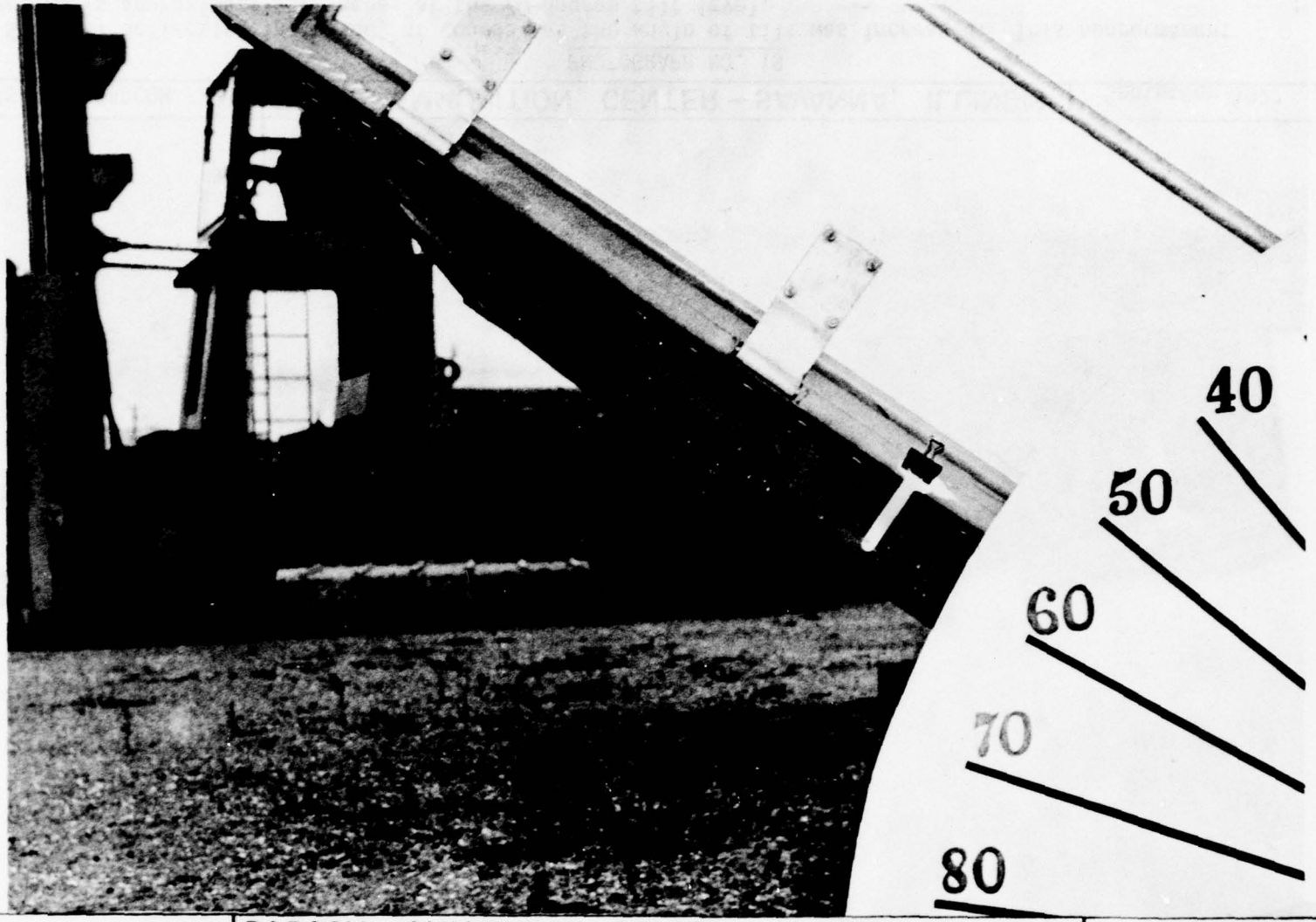
The fiberglass reinforced plywood (FRP) container, with its inert 105MM boxed ammunition load, is shown in its pre-tilt test condition.



11-078-1246/DARCOM 77	DARCOM AMMUNITION CENTER – SAVANNA, ILLINOIS	September 1977

PHOTOGRAPH NO. 16

Each container was tested in ten-degree increments. The subject container (the FRP at a 20-degree tilt in this case) and its lading and dunnage are visually inspected at each level of tilt.



11-078-1247/DARCOM 77	DARCOM AMMUNITION CENTER – SAVANNA, ILLINOIS	September 1977

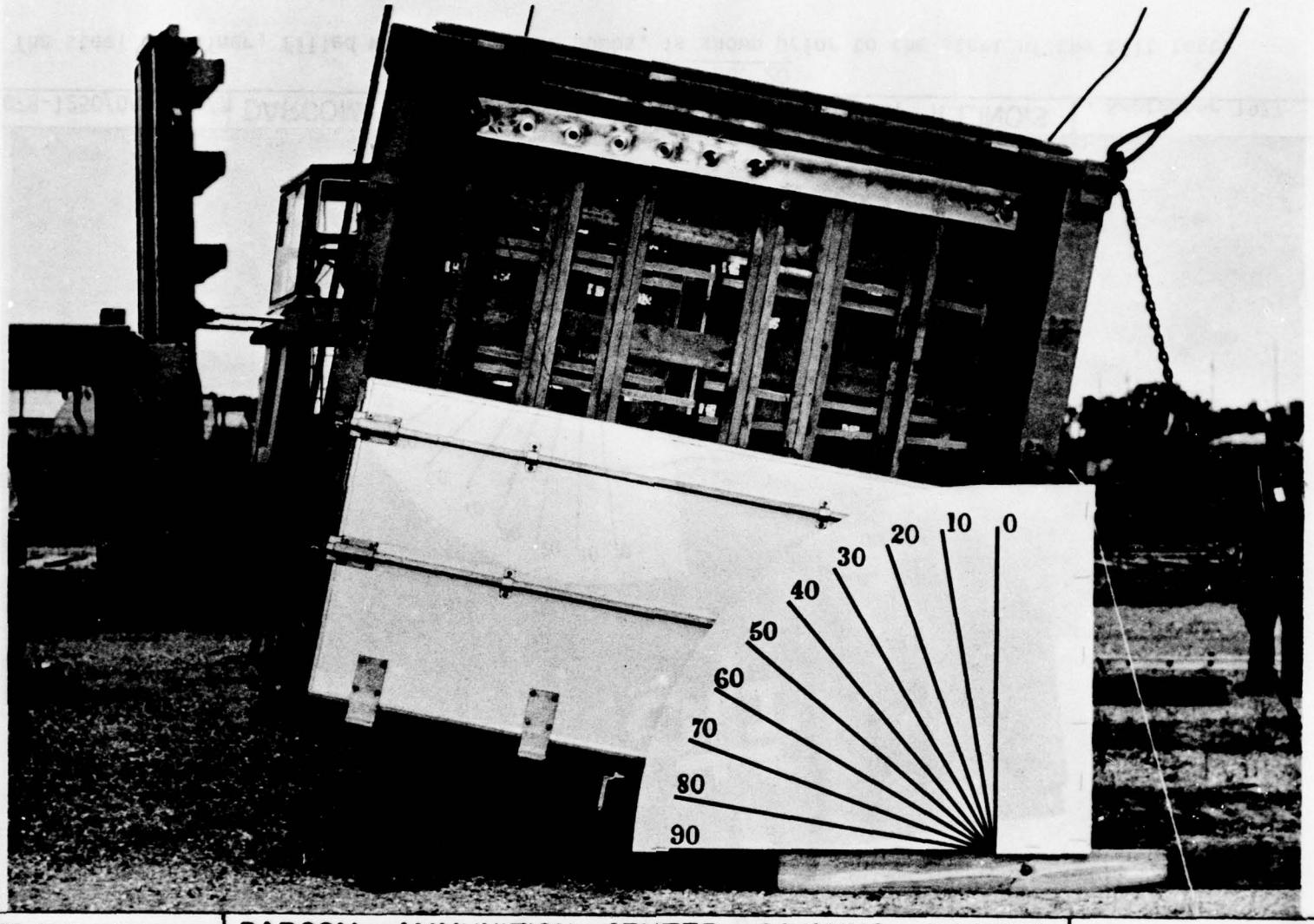
PHOTOGRAPH NO. 17

Slight bulging of the FRP container sidewall occurred at the 50-degree level due to contact with the side blocking.

11-078-1249/DARCOM 77	DARCOM AMMUNITION CENTER – SAVANNA, ILLINOIS	September 1977

PHOTOGRAPH NO. 18

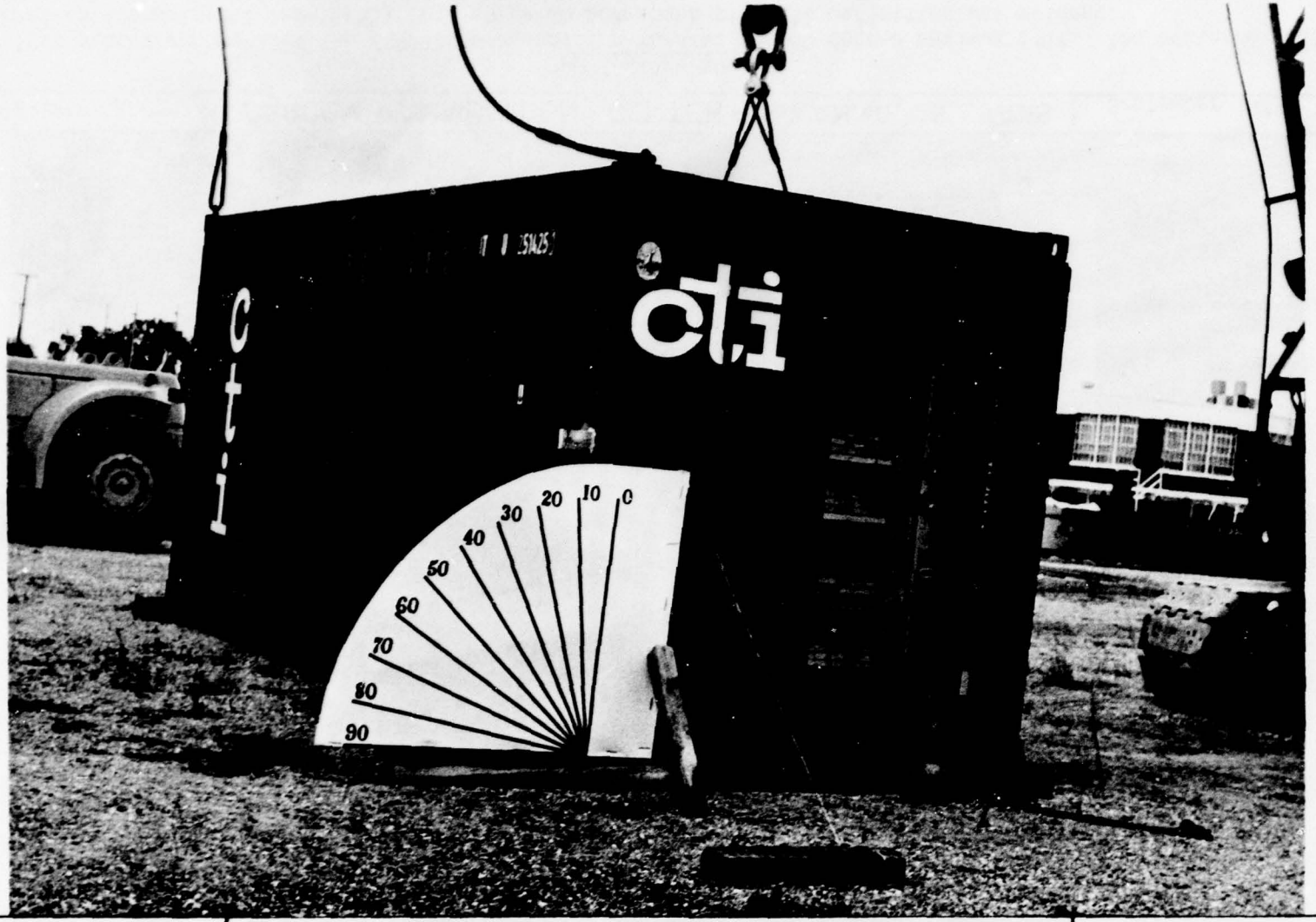
Sidewall deflection increased, of course, as the angle of tilt was increased. This nonpermanent deflection is approximately 2 inches at the 70-degree tilt level.



11-078-1248/DARCOM 77	DARCOM AMMUNITION CENTER – SAVANNA, ILLINOIS	September 1977

PHOTOGRAPH NO. 19

This photograph details the FRP 105MM ammunition load at the 80-degree maximum tilt. The container was returned to its original level position, where no permanent sidewall deflection was evident.



11-078-1250/DARCOM 77	DARCOM AMMUNITION CENTER – SAVANNA, ILLINOIS	September 1977

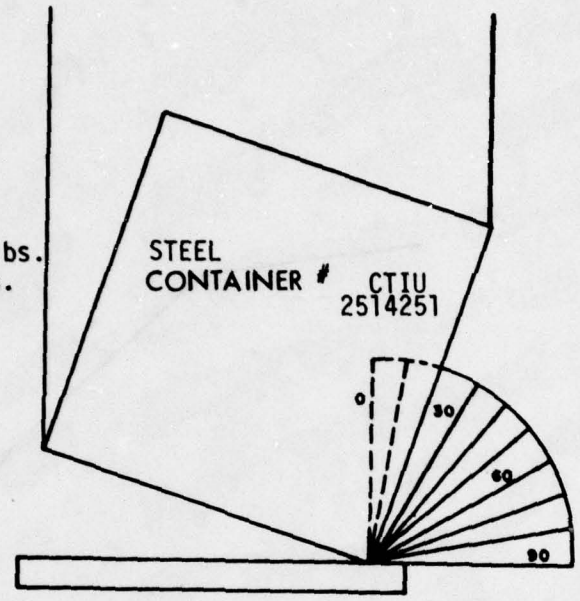
PHOTOGRAPH NO. 20

The steel container, filled with inert MK82 bombs, is shown prior to the start of the tilt test.

TILT TEST

LIFTING CRANE 40,000# CAPACITY

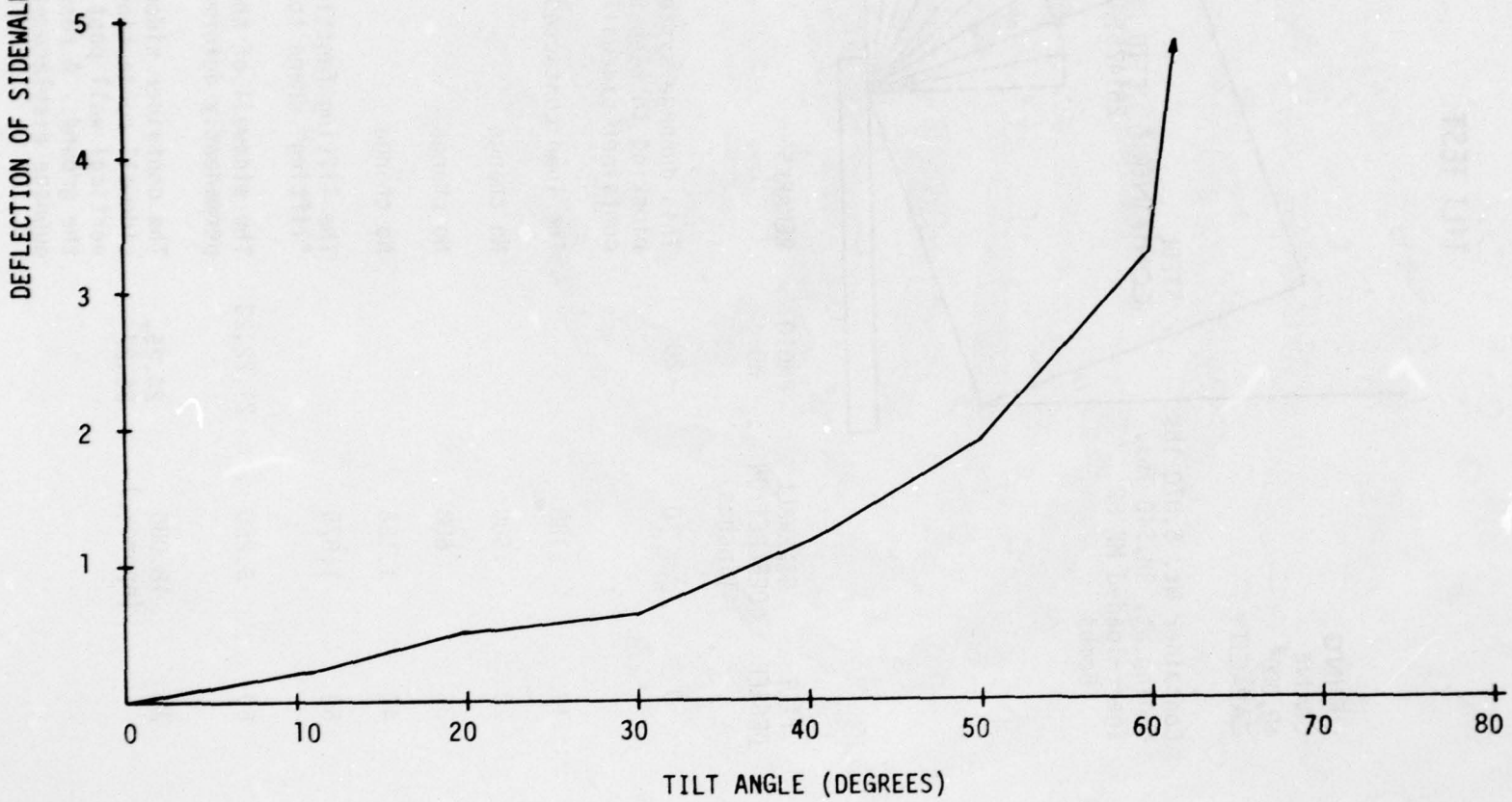
Container Wt. 5,070 lbs.
Lading Wt. 38,540 lbs.
Inert-loaded MK 82 Bombs

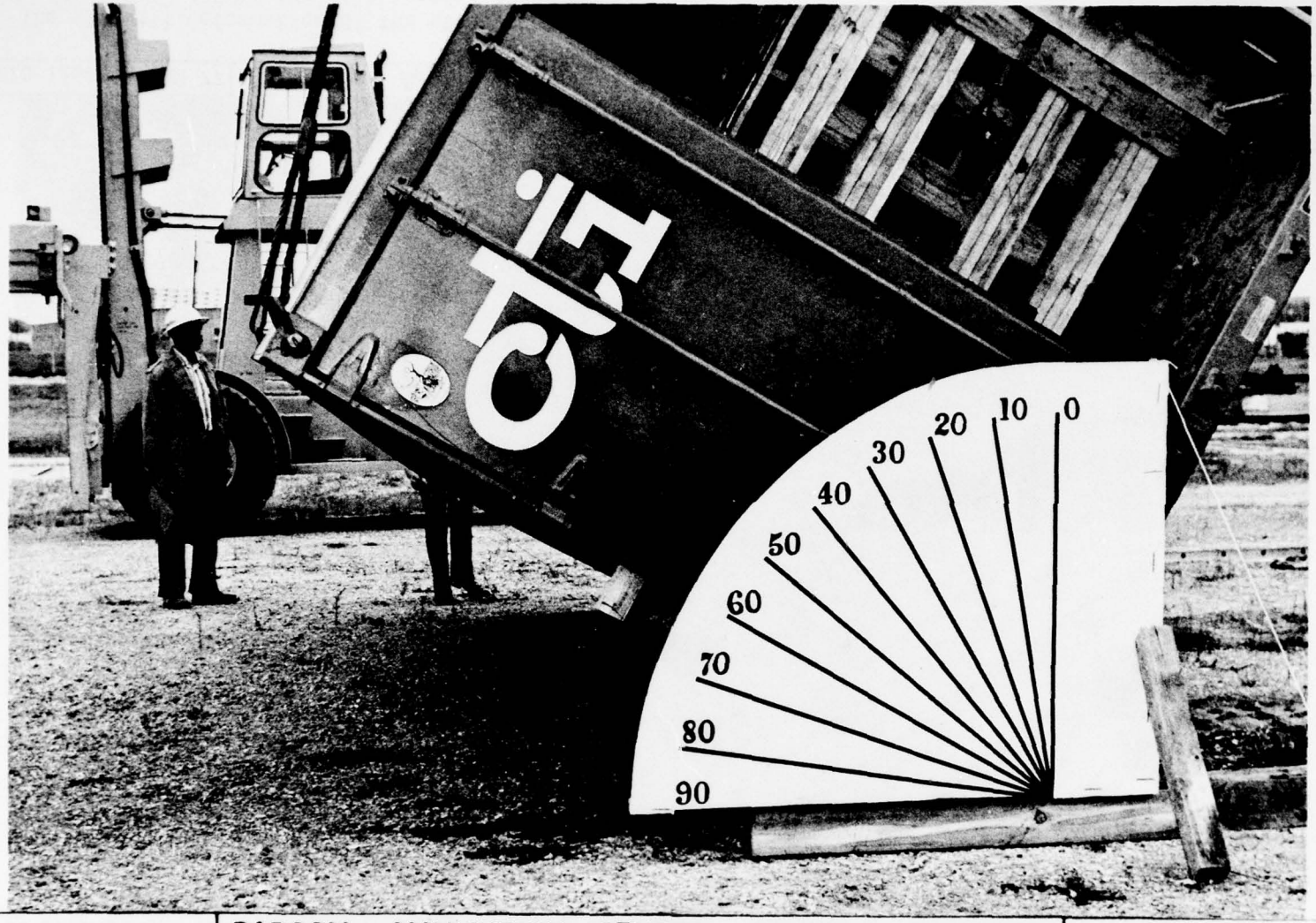


2 HOLDING CRANES 20,000# CAPACITY EACH

TILT DEGREE	SIDEWALL DEFLECTION (inches)	PHOTO NO.	REMARKS
0	0	20	This dunnage system contained no side blocking to keep the load off of the container sidewall.
12	.188		The load contacted the sidewall.
20	.500		No change
30	.688		No change
40	1.188		No change
50	1.875		The lifting function shifted from the "lifting" crane to the two "holding" cranes.
60	3.250	21,22,23	The sidewall of the container began to permanently deform.
78	18.000 (approx.)	24,25, 26,27	The container sidewall failed, with the sidewall contacting the ground while the vertical wall post was 12 degrees off the ground. A resulting lading and dunnage displacement occurred.

TILT TEST OF STEEL CONTAINER LOADED WITH MK82 BOMBS

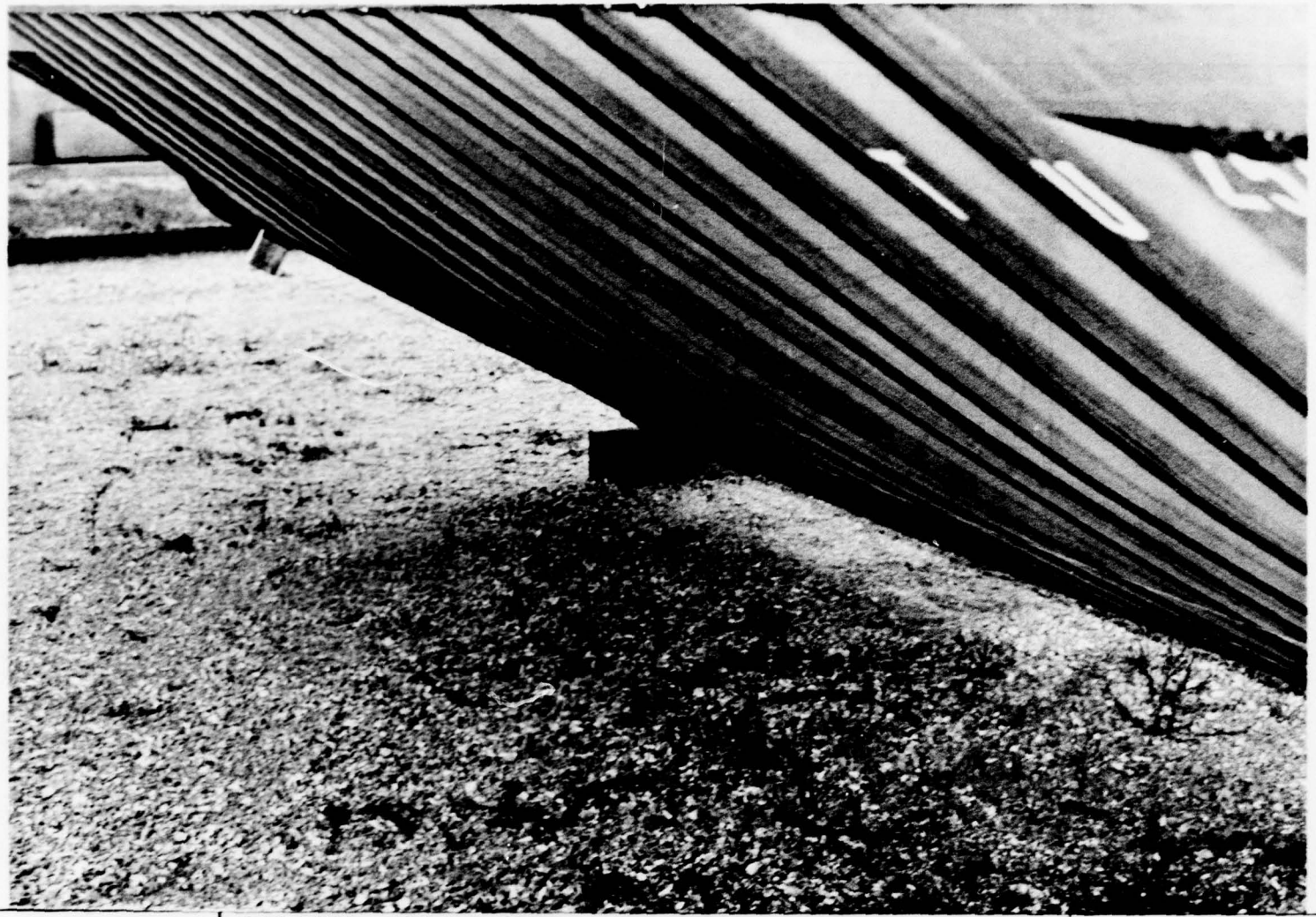




11-078-1257/DARCOM 77	DARCOM AMMUNITION CENTER – SAVANNA, ILLINOIS	September 1977

PHOTOGRAPH NO. 21

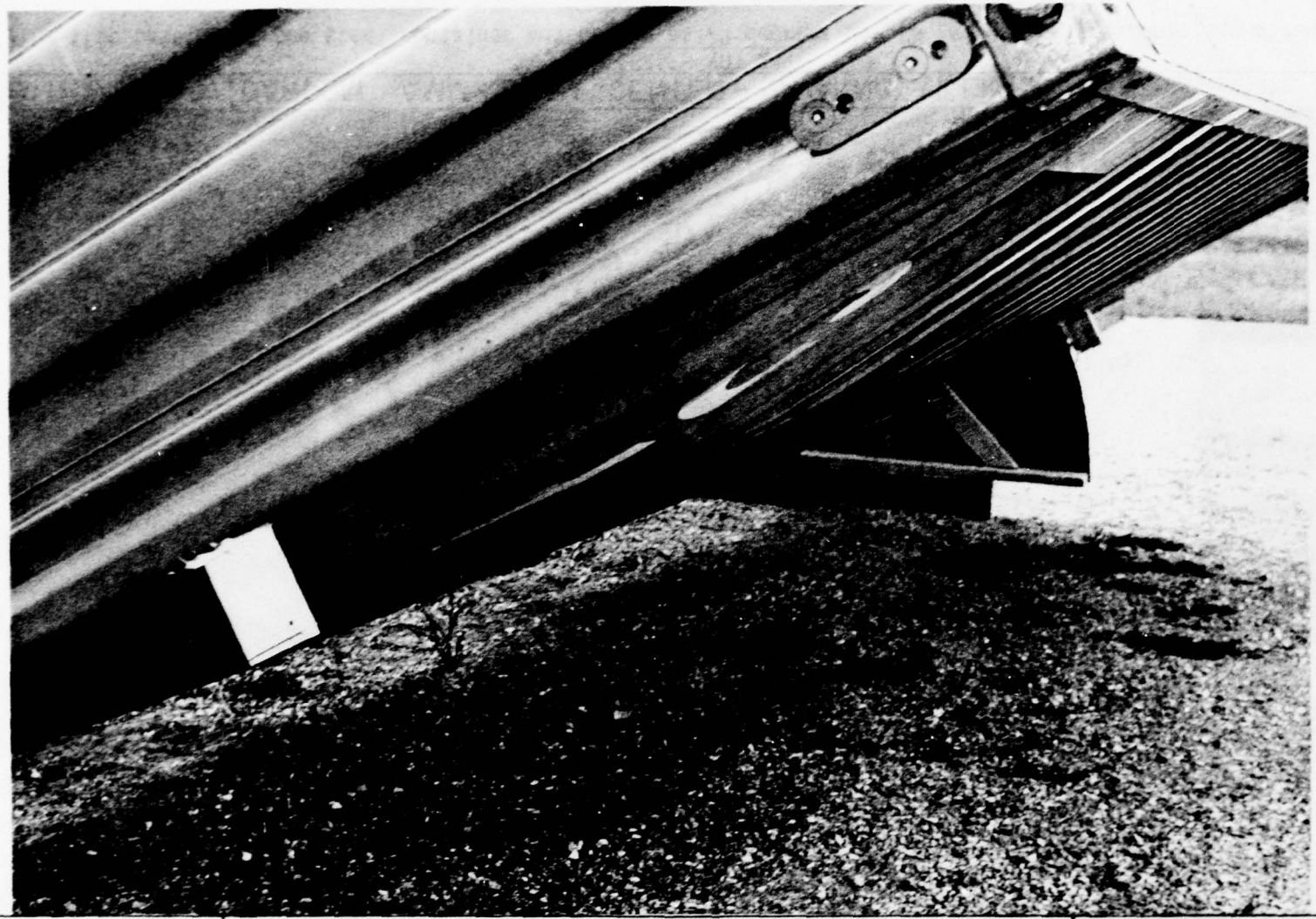
Sidewall deflection of the steel container, which did not contain side blocking, totaled over 3 inches at the 60-degree angle of tilt.



11-078-1256/DARCOM 77	DARCOM AMMUNITION CENTER – SAVANNA, ILLINOIS	September 1977

PHOTOGRAPH NO. 22

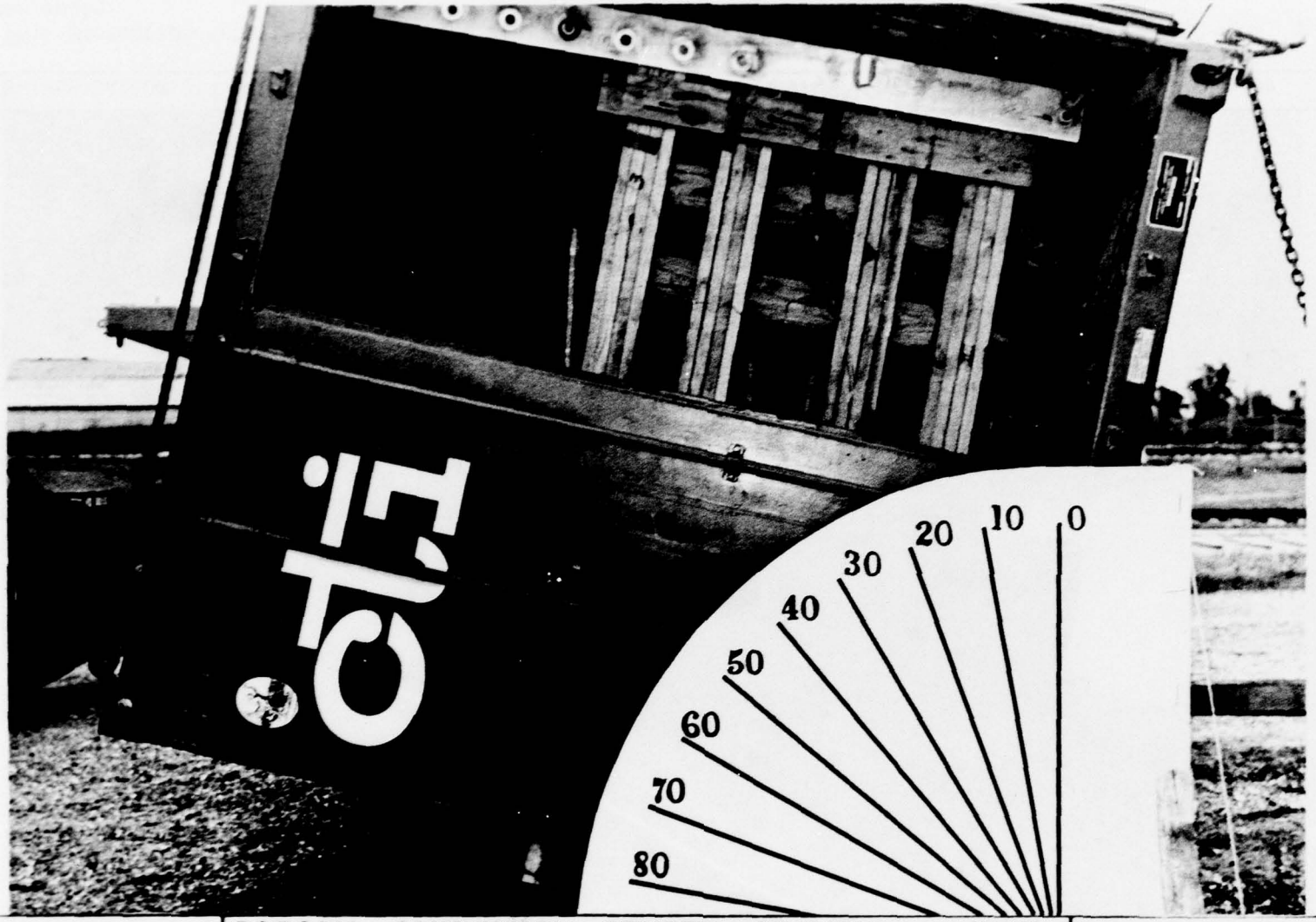
The sidewall deformation of the steel container at the 60-degree level of tilt was the first permanent deformation noted during the tilt testing program.



11-078-1258/DARCOM 77	DARCOM AMMUNITION CENTER – SAVANNA, ILLINOIS	September 1977

PHOTOGRAPH NO. 23

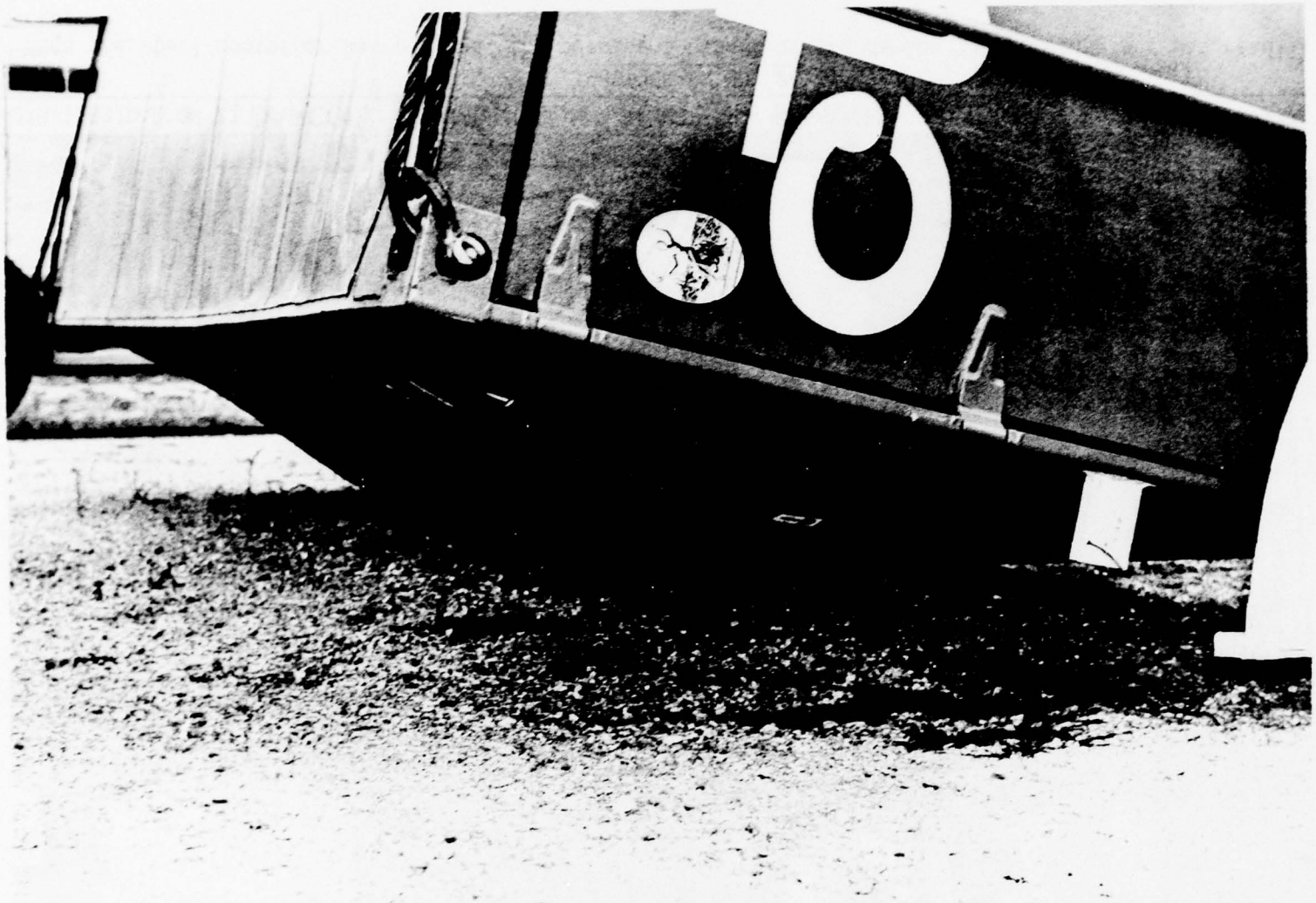
This photograph from the front of the steel container shows the permanent sidewall deformation from another angle.



11-078-1254/DARCOM 77	DARCOM AMMUNITION CENTER – SAVANNA, ILLINOIS	September 1977

PHOTOGRAPH NO. 24

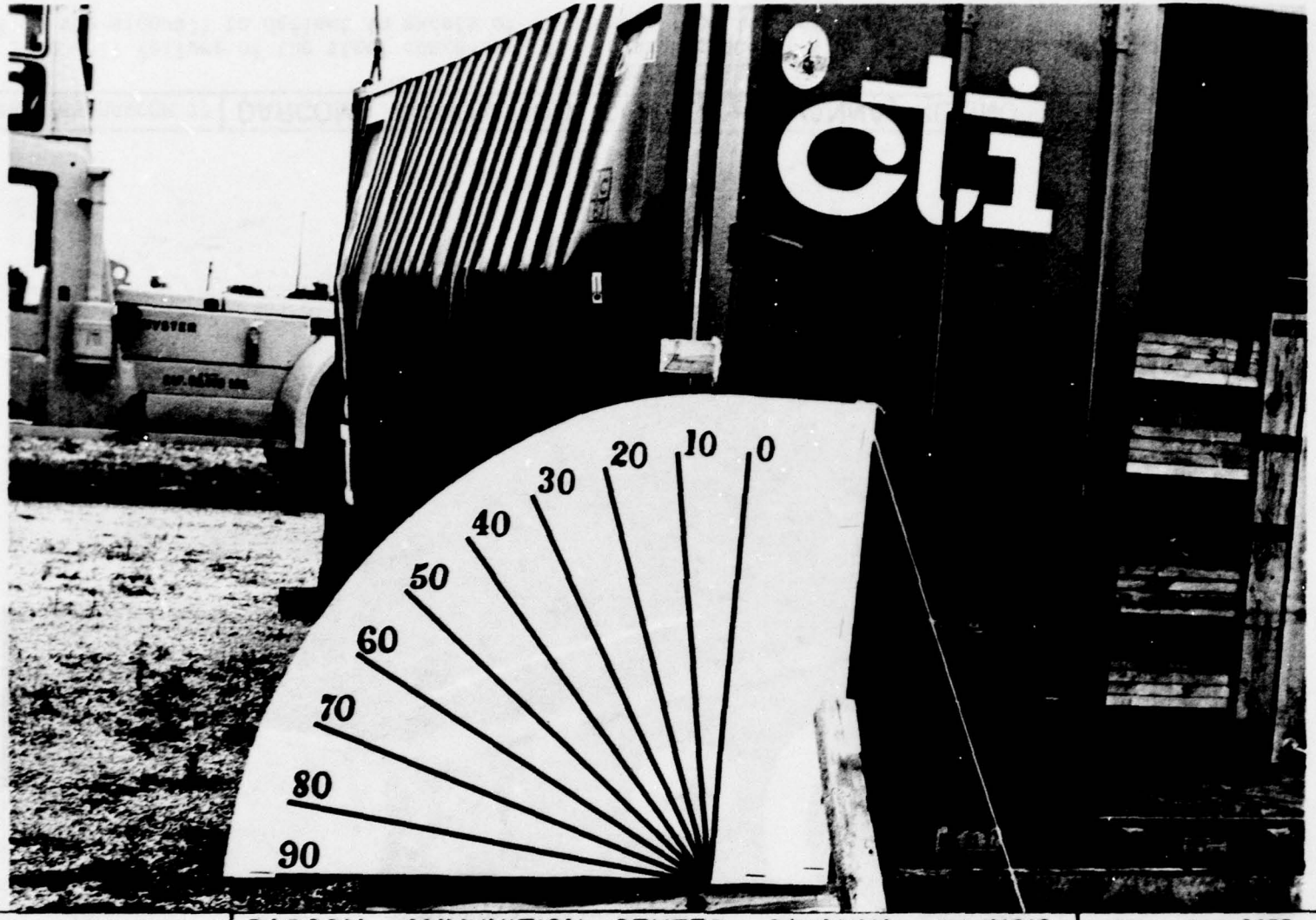
The tilt testing of the steel container was halted at 78 degrees due to failure of the container sidewall.



11-078-1255/DARCOM 77	DARCOM AMMUNITION CENTER – SAVANNA, ILLINOIS	September 1977

PHOTOGRAPH NO. 25

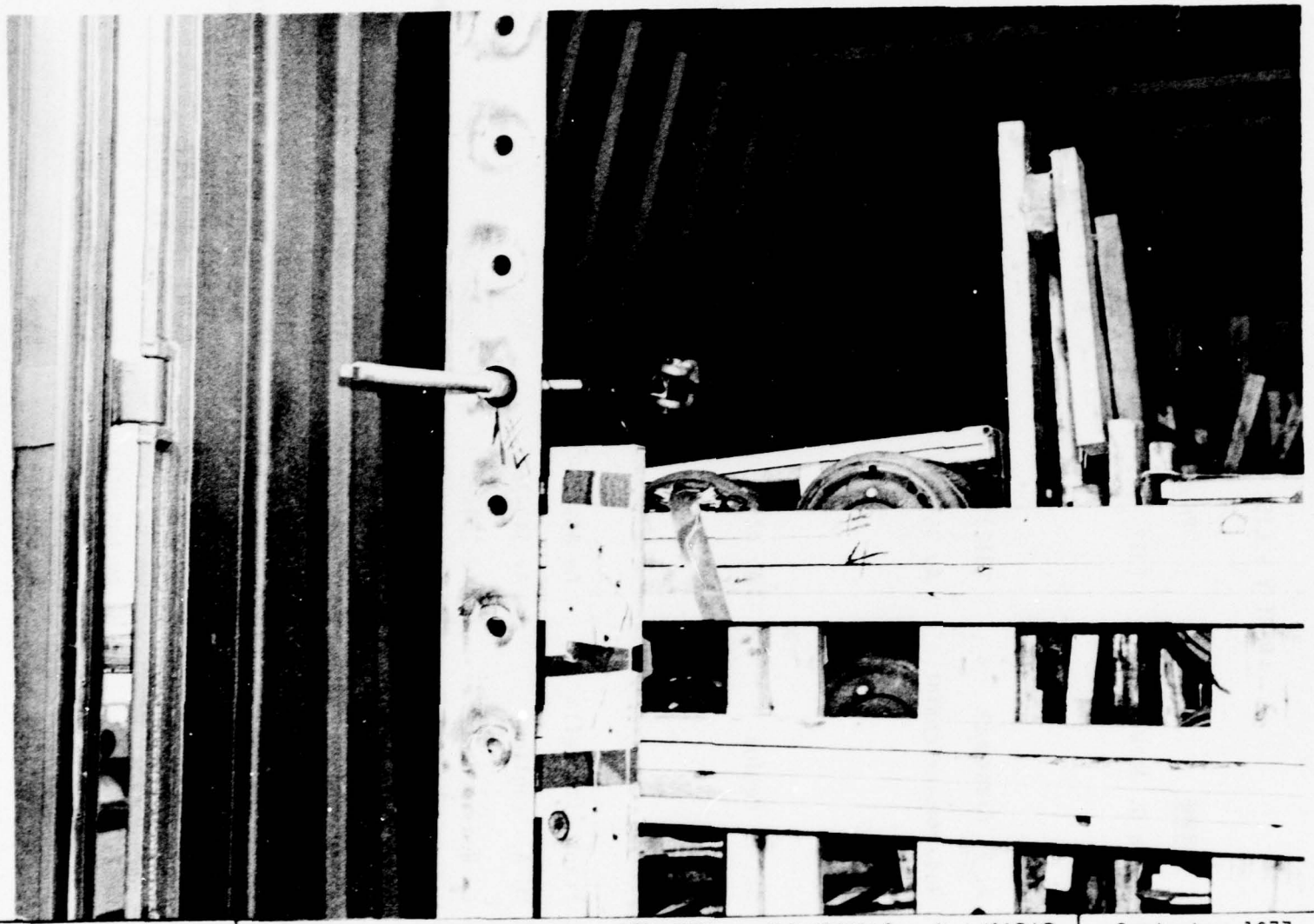
Side wall failure of the steel container, due to an absence of side blocking, was sufficiently severe to allow the sidewall to deflect in excess of 12 degrees from its original condition.



11-078-1253/DARCOM 77	DARCOM AMMUNITION CENTER – SAVANNA, ILLINOIS	September 1977

PHOTOGRAPH NO. 26

When the steel container was righted, the permanent nature of the damage to the container was readily apparent.



11-078-1252/DARCOM 77	DARCOM AMMUNITION CENTER – SAVANNA, ILLINOIS	September 1977

PHOTOGRAPH NO. 27

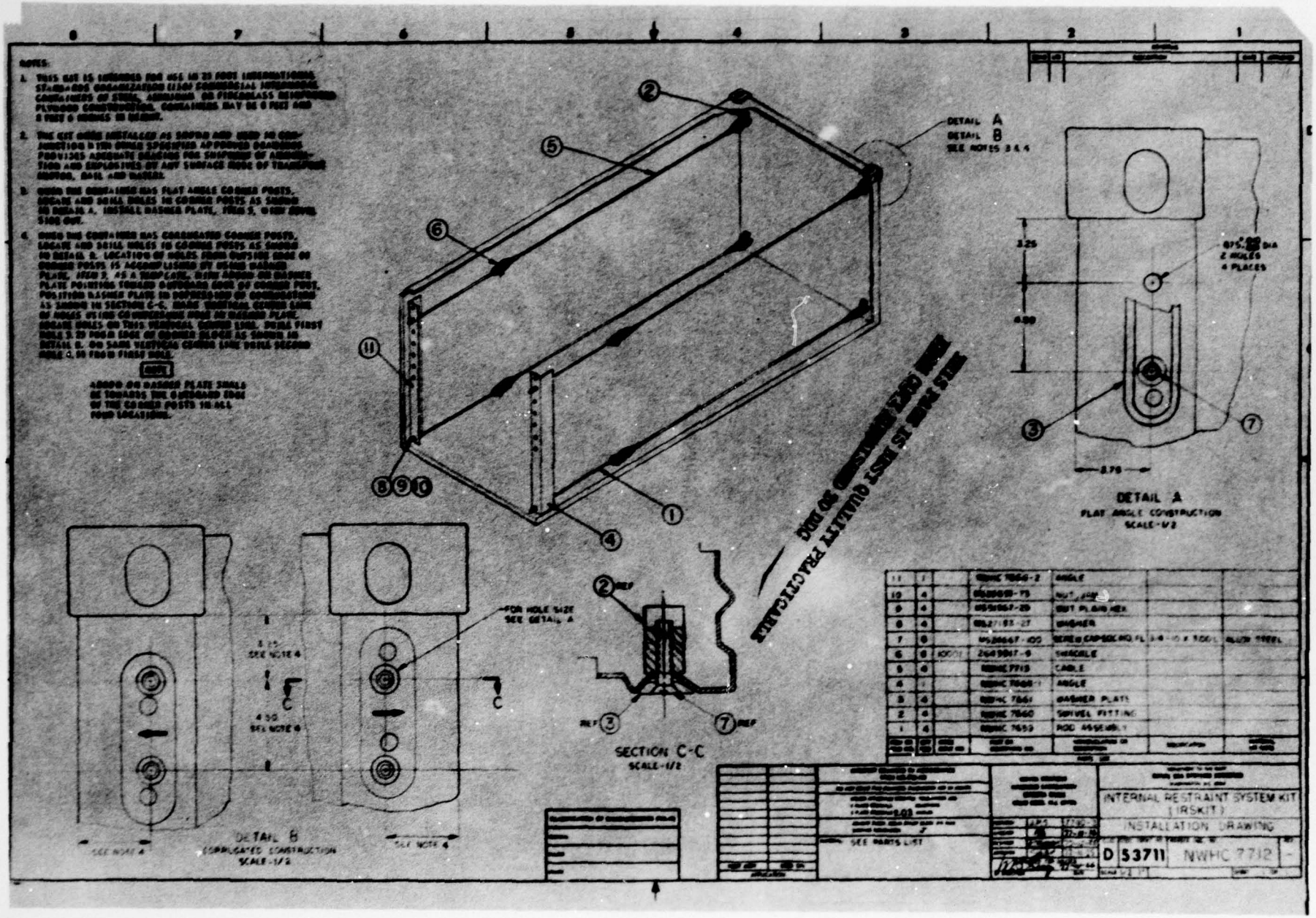
A post tilt test inspection of the steel container revealed displaced dunnage and inert MK82 bombs. Direct contact of the bombs with the container sidewall caused sidewall localized loading and failure.

PART V - LIST OF ATTENDEES

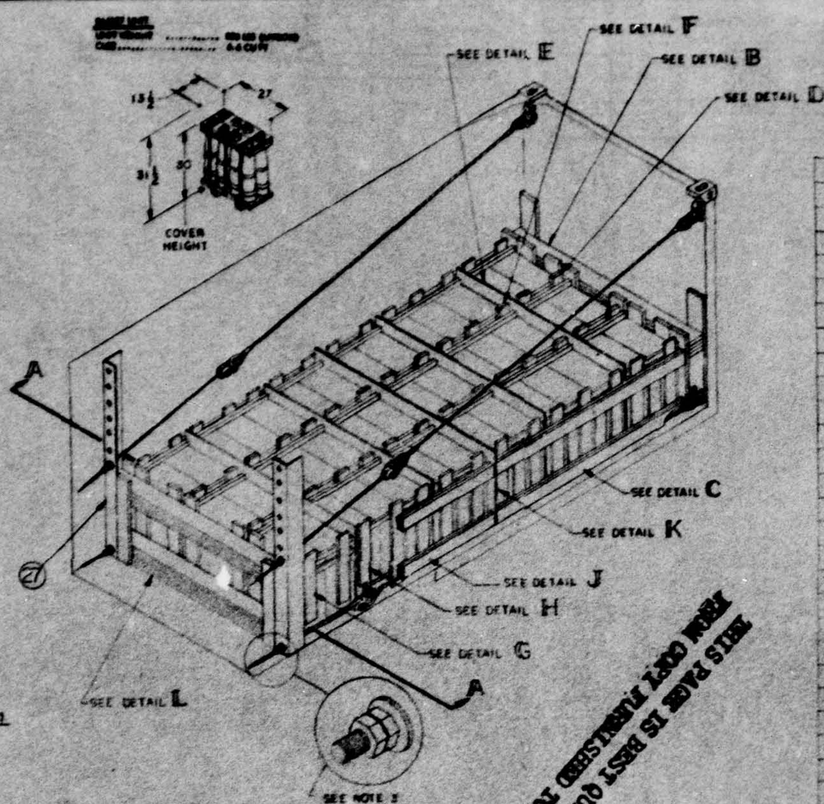
NAME	PHONE	ADDRESS
Mr. James D. Jarvis	(312) 939-0774	Bureau of Explosives Association of American Railroads 59 E. Van Buren St. Chicago, IL 60605
Mr. A. F. Grassmuck	(312) 939-0779	Same
Mr. Rudy Messerschmidt	Av 354-5806	Commander US Army Mobility Equipment Research and Development Command ATTN: DRDME-HT Ft. Belvoir, VA 22060
Mr. Sal R. Petioa	Av 449-7502	Commander US Naval Weapons Station, Earle Naval Weapons Handling Center CODE 8021 Colts Neck, NJ 07722
Mr. Frank Ciccolella	Av 449-7502	Same
Mr. M. A. Scaglione	Av 449-7502	Same
Mr. L. Roessner	Av 284-8251	Commander US Army Materiel Development and Readiness Command ATTN: DRCPM-CS 5001 Eisenhower Ave. Alexandria, VA 22333
Mr. Eric Jackson	Av 585-8550	Director US Army Materiel Development and Readiness Command Ammunition Center ATTN: SARAC-MLE Savanna, IL 61074
Mr. D. I. Willis	AV 585-8563	Same ATTN: SARAC-DEO
Mr. George Phillips	Av 585-8528	Same

NAME	PHONE	ADDRESS
Mr. Bill Ernst	Av 585-8551	Director US Army Materiel Development and Readiness Command Ammunition Center ATTN: SARAC-DEV Savanna, IL 61074
Mr. Jack Kenna	Av 585-8588	Same
Mr. Stan Nehrkorn	Av 585-8588	Same
Mr. Robert Monroe	Av 585-8552	Same
Mr. M. H. Allen	(202) 426-1577	US Coast Guard Hazardous Cargo Division 7th and C Streets, SW Washington, DC 20590

APPENDIX A


NOTES:
1. THIS KIT IS INTENDED FOR USE IN 20 FOOT INTERNATIONAL STANDARDS ORGANIZATION (ISO) COMMERCIAL INTERMODAL CONTAINERS OF STEEL, ALUMINUM OR FIBERGLASS REINFORCED PLYWOOD CONSTRUCTION. CONTAINERS MAY BE 8 FEET AND 8 FEET 6 INCHES IN HEIGHT.
2. THE KIT WHEN INSTALLED AS SHOWN AND USED IN CONJUNCTION WITH OTHER SPECIFIED APPROVED HARDWARE PROVIDES ADEQUATE BRACING FOR SHIPMENT OF AMMUNITION AND EXPLOSIVES OF ANY SURFACE MODE OF TRANSPORTATION, RAIL AND WATER.
3. WHEN THE CONTAINER HAS FLAT ANGLE CORNER POSTS, LOCATE AND DRILL HOLES IN CORNER POSTS AS SHOWN IN DETAIL A. INSTALL WASHER PLATE, ITEM 5, WITH ROUND SIDE OUT.
4. WHEN THE CONTAINER HAS CORRUGATED CORNER POSTS, LOCATE AND DRILL HOLES IN CORNER POSTS AS SHOWN IN DETAIL B. LOCATION OF HOLES FROM BOTTOM SIDE OF CORNER POSTS IS ACCEPTABLE EITHER BEFORE WASHER PLATE, ITEM 5, IS A SUBPLATE, WITH ANGLE OR WASHER PLATE POSITIONED TOWARD OUTBOARD SIDE OF CORNER POST. POSITION WASHER PLATE IN PREFERRED OR ALTERNATE AS SHOWN IN SECTION C-C. DRAW VERTICAL CENTER LINE OF HOLES USING CONVENIENT SIDE OF WASHER PLATE. SPACE HOLES ON THIS VERTICAL CENTER LINE, DRILL FIRST HOLE 3.25 FROM EDGE OF CORNER BLOCK AS SHOWN IN DETAIL B. ON SAME VERTICAL CENTER LINE DRILL SECOND HOLE 4.50 FROM FIRST HOLE.
NOTE
ARROW ON WASHER PLATE SHALL BE TOWARDS THE OUTBOARD SIDE OF THE CORNER POSTS IN ALL FOUR LOCATIONS.
DETAIL A
DETAIL B
SEE NOTES 3 & 4
3.25
4.50
Ø.75 DIA 2 HOLES 4 PLACES
2.75
DETAIL A
FLAT ANGLE CONSTRUCTION
SCALE-1/2
FOR HOLE SIZE SEE DETAIL A
SEE NOTE 4
SEE NOTE A
DETAIL B
CORRUGATED CONSTRUCTION
SCALE-1/2
SECTION C-C
SCALE-1/2
REF
SEE PARTS LIST
INTERNAL RESTRAINT SYSTEM KIT (IRSKIT)
INSTALLATION DRAWING
D 53711
NWHC 7712

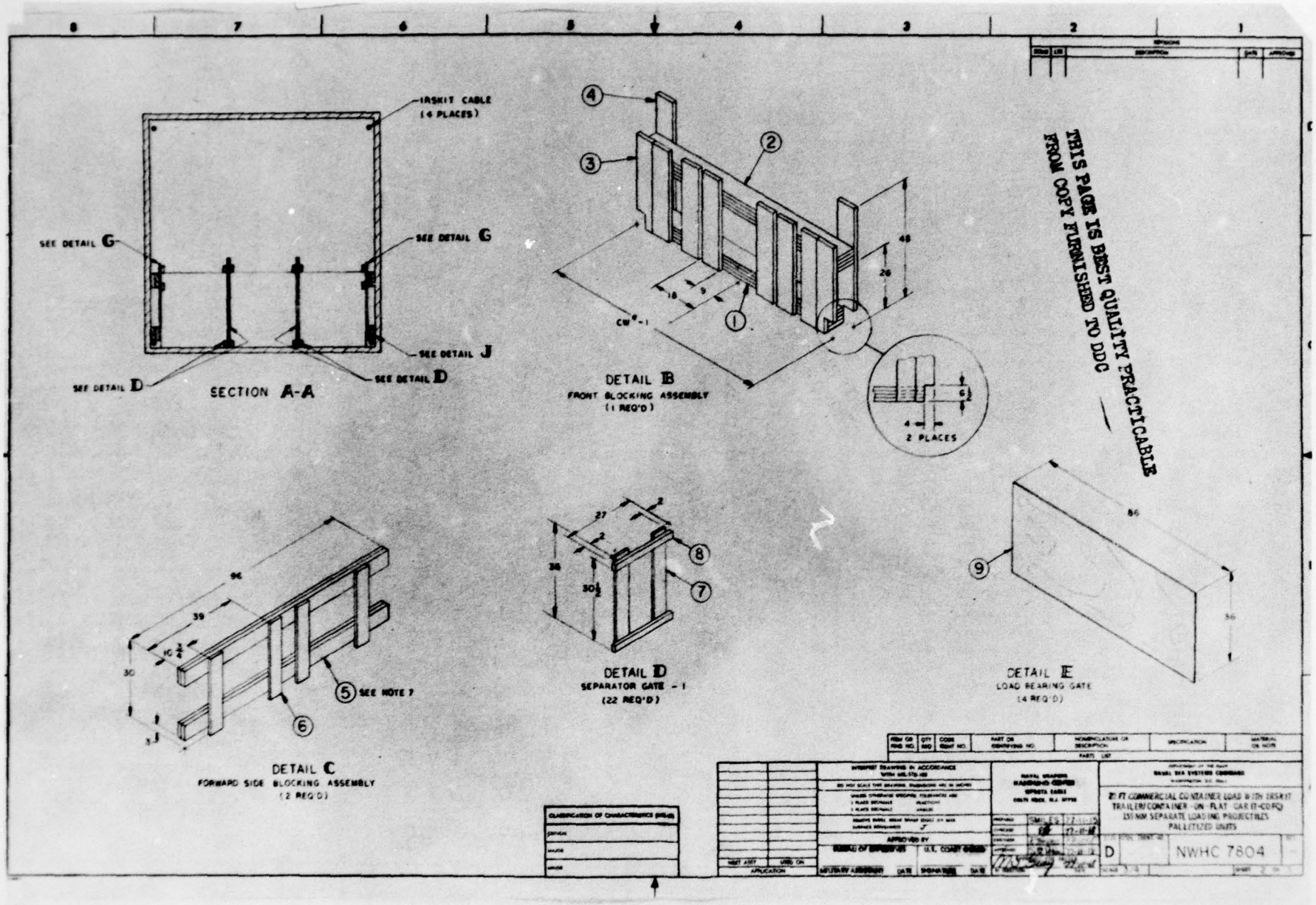
APPENDIX B



NAVAL SEA SYSTEMS COMMAND

20FT COMMERCIAL CONTAINER LOAD WITH [illegible]
TRAILER/CONTAINER - ON - FLAT - CAR [illegible]
[illegible] SEPARATE LOADING PROJECTILES
PALLETIZED UNITS

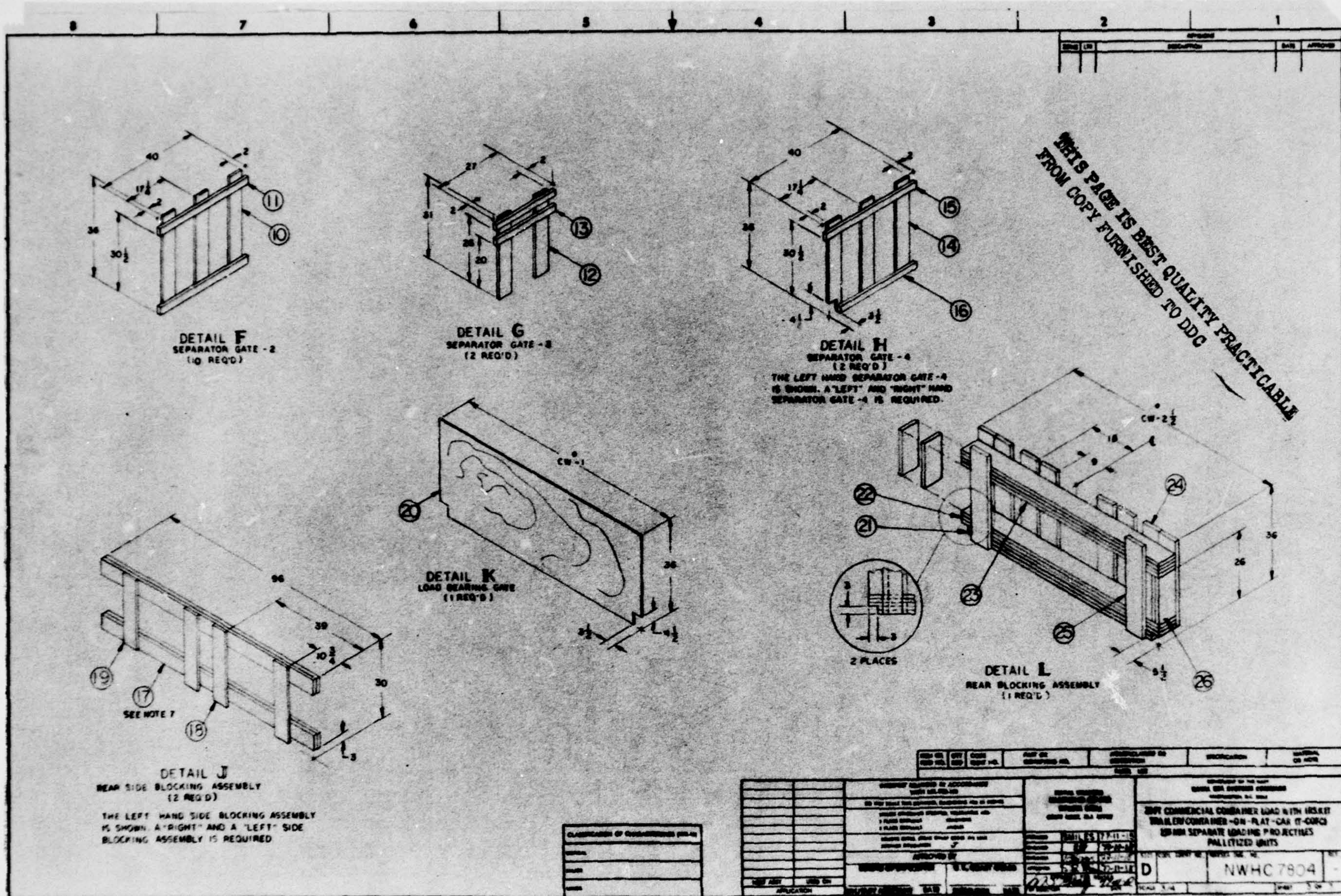
D NWHC 7804



20 FT COMMERCIAL CONTAINER LOAD WITH IRSKIT
TRAILER/CONTAINER - ON - FLAT CAR IT-CO-FQ
151 NM SEPARATE LOADING PROJECTILES
PALLETIZED UNITS

NWHC 7804

D


DETAIL F
SEPARATOR GATE - 2
(10 REQ'D)
DETAIL G
SEPARATOR GATE - 3
(2 REQ'D)
DETAIL H
SEPARATOR GATE - 4
(2 REQ'D)
THE LEFT HAND SEPARATOR GATE-4 IS SHOWN. A "LEFT" AND "RIGHT" HAND SEPARATOR GATE-4 IS REQUIRED.
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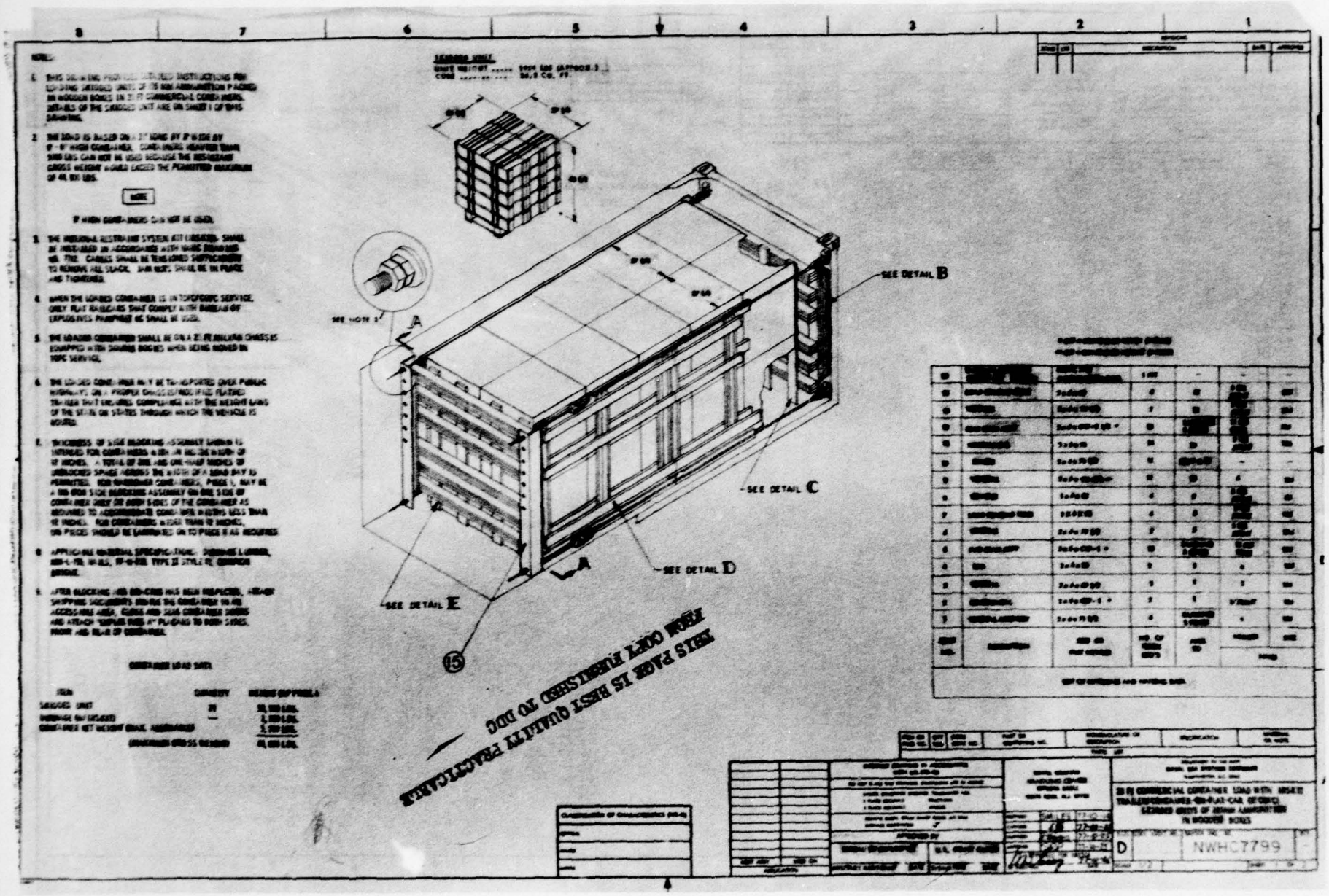
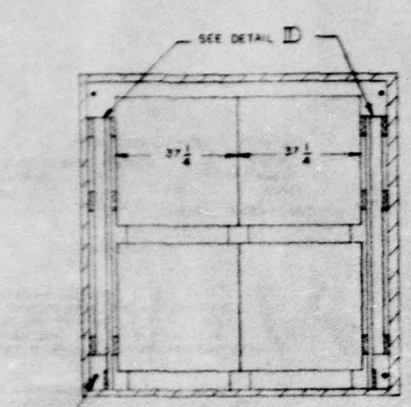
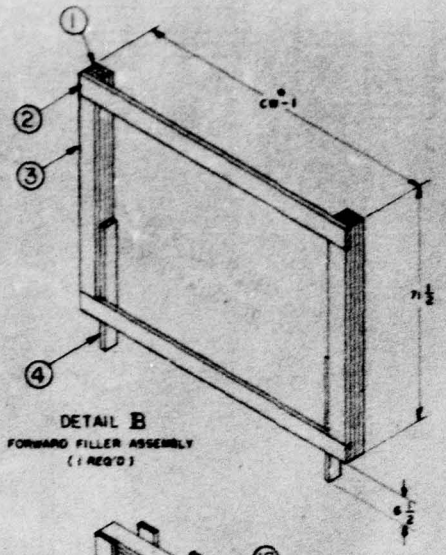
DETAIL K
LOAD BEARING GATE
(1 REQ'D)
DETAIL J
REAR SIDE BLOCKING ASSEMBLY
(2 REQ'D)
THE LEFT HAND SIDE BLOCKING ASSEMBLY IS SHOWN. A "RIGHT" AND A "LEFT" SIDE BLOCKING ASSEMBLY IS REQUIRED
SEE NOTE 7
2 PLACES
DETAIL L
REAR BLOCKING ASSEMBLY
(1 REQ'D)
NWHC 7804

APPENDIX C

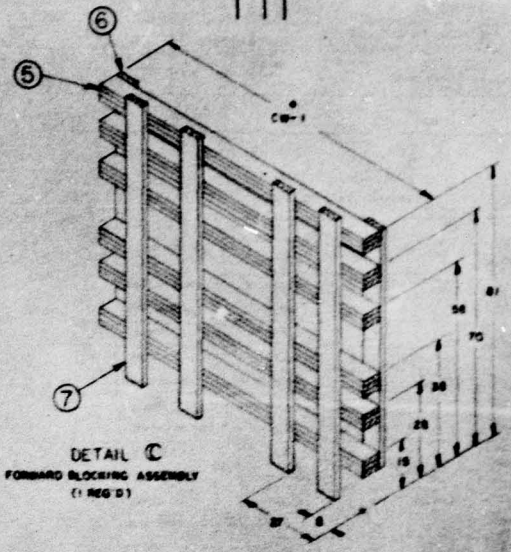




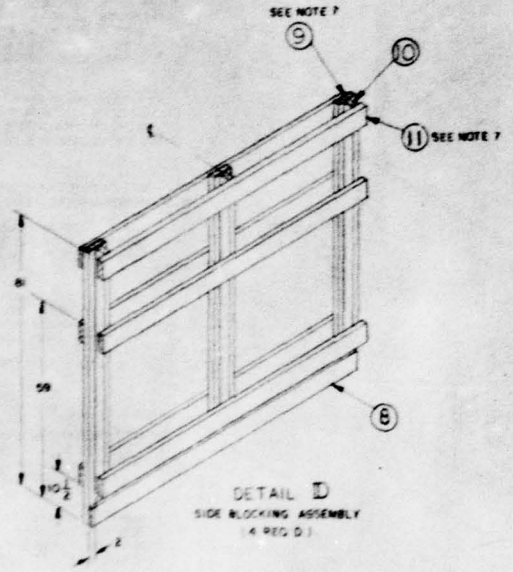
SECTION A-A



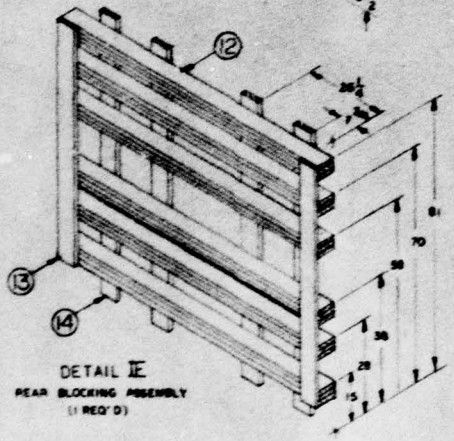
DETAIL B
FORWARD FILLER ASSEMBLY
(1 REQ'D)



DETAIL C
FORWARD BLOCKING ASSEMBLY
(1 REQ'D)



DETAIL D
SIDE BLOCKING ASSEMBLY
(4 REQ'D)

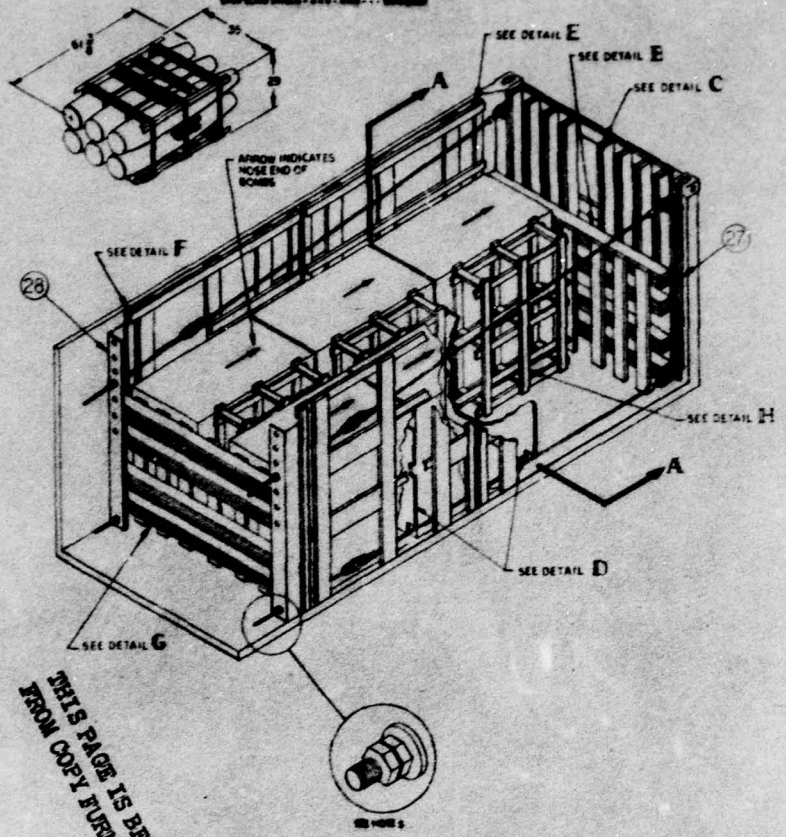


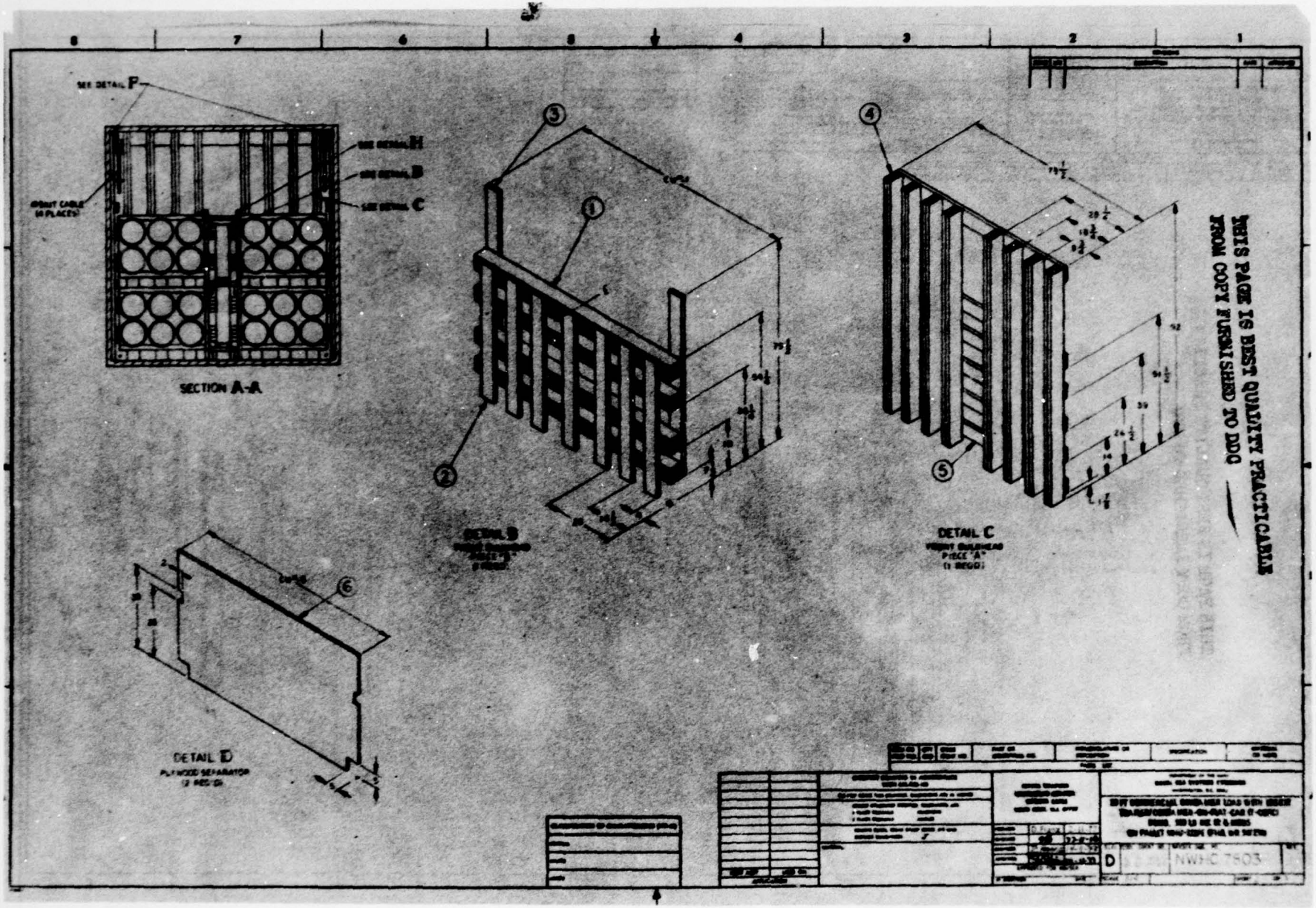
DETAIL E
REAR BLOCKING ASSEMBLY
(1 REQ'D)

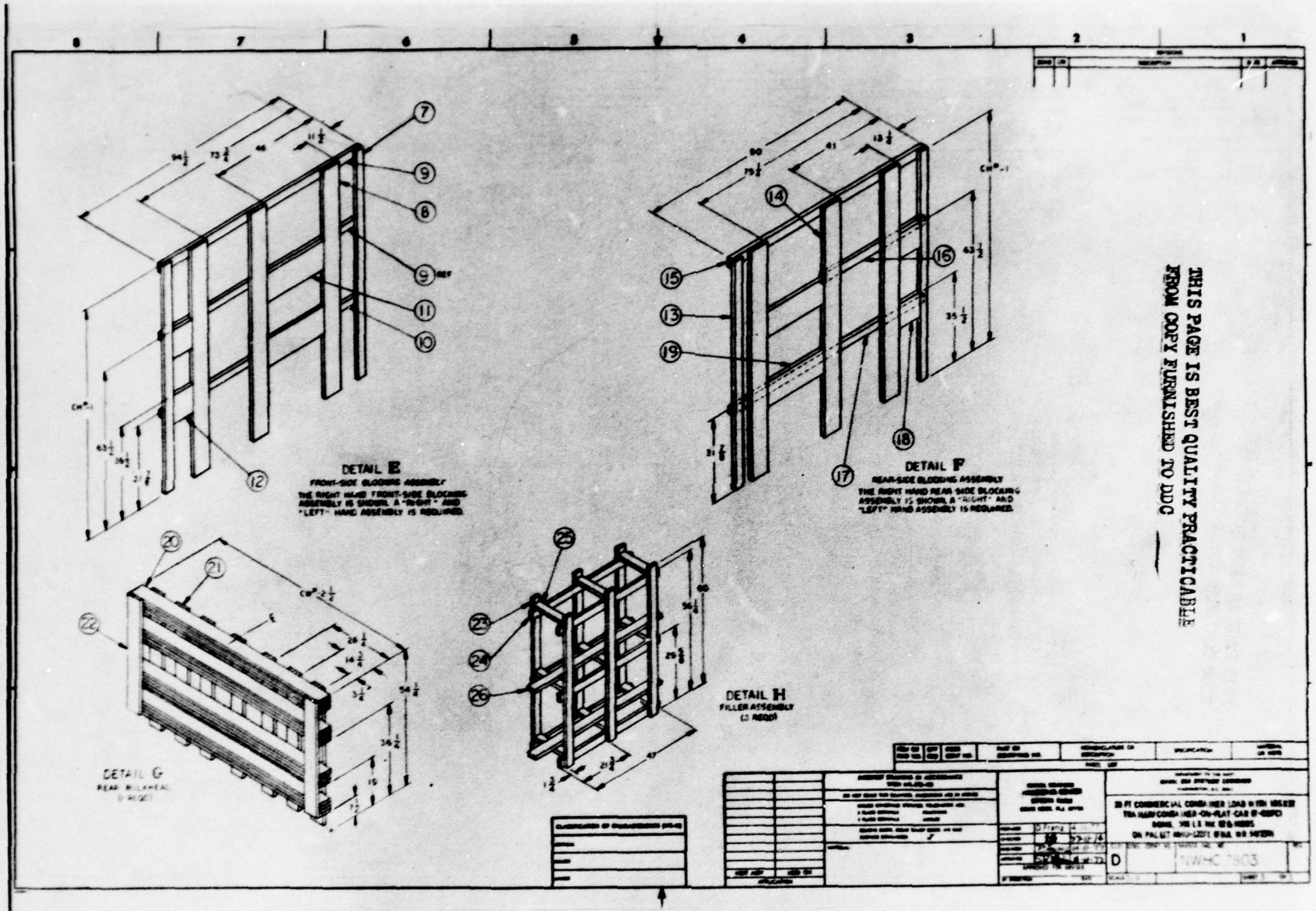
* CW = CONTAINER WIDTH (INSIDE)

D NWHC 7799

APPENDIX D







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